OIL, GAS & PETROCHEMICAL PROCESSING

# Petroleum Refiner

APRIL
1958

## SPECIAL REPORT-NATURAL GASOLINE

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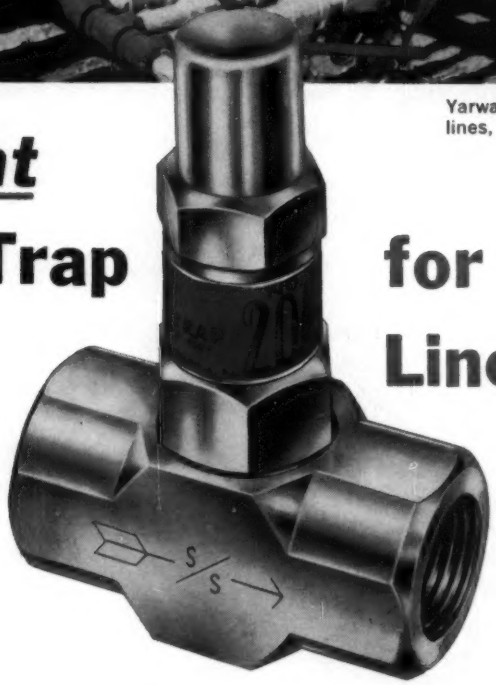


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Volume 37, No. 4 April, 1958

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Petroleum
Refiner
OIL, GAS AND PETROCHEMICAL PROCESSING

# A Quick Look at This Issue

These handy digests permit checking the articles you want to read first. ☑

SPECIAL REPORT ON NATURAL GASOLINE

☐ **How This Plant Went Automatic . . .** Union found a good payout in converting its Playa Del Rey Plant to unattended operation. In this article you'll find how they did it and what the cost figures are for the operation after three years' experience. Turn to **Page 136.**

☐ **Computer Designs Plants . . .** The trend to smaller gasoline plants has made for extensive calculations on plant design to justify installations in small gas fields. That's where computers can help a lot. The first step is the primary absorber calculation as described in this article on **Page 140.**

☐ **Slime Control—What You Should Know . . .** It takes a combination of science and art to keep slime under control in cooling towers, but it can be done effectively and economically. To find out why and how it will pay you to solve this troublesome operating problem turn to **Page 141.**

☐ **Are You Over-Lubricating Engines? . . .** It can be just as harmful as under-lubrication. Phillips made big maintenance savings by cutting oil consumption. How they did it is described in this article on **Page 145.**

☐ **Wellman Plant Uses Ammonia Cycle . . .** Refrigerating the gas charge to this plant with an ammonia absorption cycle eliminates the need for dehydrating tail gases later. Investment for this new plant was cut by using a hydraulic system for driving process pumps and cooling tower fan. How this process works is shown on **Page 147.**

☐ **Natural Gasoline Plant Safety . . .** In 13 years Phillips Petroleum Company's natural gasoline department has reduced its accident frequency rate from an abnormally high average to one of the nation's lowest. For a detailed description of the department's safety philosophy, organization plan and safety program, turn to **Page 149.**

Please Turn Page →

## A Quick Look at This Issue . . .

☐ **Better Estimate of Entrainment From Bubble-Cap Trays . . .** For the first time, design charts are presented for estimating both entrainment and flooding in bubble-cap columns. In the region where entrainment affects distillation efficiency significantly, the correlations shown here represent experimental data within 20 percent. Turn to **Page 153.**

☐ **Design Tips for Your Motor Circuits . . .** The first part of this series covered the design requirements of motor circuit conductors. This second, and final part, completes the design procedure for motor circuits by describing the methods of selecting the required protective devices. For complete details, turn to **Page 159.**

☐ **A Refinery "Hall of Fame" . . .** PETROLEUM REFINER is planning to publish a "Hall of Fame" of those men who have contributed the most to the oil, gas and petrochemical processing industry. But it's up to you to choose who should be included. For more details, turn to **Page 164.**

☐ **Design Packed Columns Graphically . . .** A group of diagrams are presented in this article which will make the design of packed columns much easier. The authors tell you what they used as the basis for these diagrams, then compare the results with more exacting methods. Turn to **Page 165.**

☐ **Applied Hydrocarbon Thermodynamics (Part 4) . . . Compressibility Factors and Equation of State Correlations . . .** here are the real working correlations and graphs which you will be able to use pronto. Open your working notebook and fill it with these charts from **Page 173.**

☐ **Know Your Asphalts (Part 8) . . .** Special tests are required for roofing asphalts. The importance of these tests and the information obtained from them is discussed. More data for your asphalt notebook when you turn to **Page 180.**

☐ **Figure Cost of Getting More Octanes . . .** Refining processes commercially available now will satisfy the octane demand for the next five years. This article predicts the future octane demand and calculates the cost of satisfying this demand with a typical Gulf Coast refinery. Compare the future process needs with your present facilities. Turn to **Page 181.**

☐ **Try MIBK in Your Wax Deoiling Unit . . .** Here is the story of one company which did and they liked the results. Compare the points they considered with your own operation. Turn to **Page 189.**

☐ **Watch the Weather When Building . . .** Once built, most structures will withstand hurricanes. But during the actual construction, the job is vulnerable to even "moderate" forms of weather like rains, winds, snows, and freezes. Recent experiences show a specialized weather service can give substantial savings. Read about how to make risk decisions. Turn to **Page 193.**

☐ **How an Old Rubber Plant Went Modern . . .** American Synthetic Rubber Corp. added new capacity and became one of the most versatile synthetic rubber producers. New chemical preparation and automatic metering facilities permit running many varieties of rubber. Unique design of the recovery system gives new economies in maintenance and operation. For the complete story on how this producer meets competition, turn to **Page 197.**

☐ **Find Tank Cost by Nomogram . . .** Knowing the cost and volume of one tank and using this nomogram one can quickly estimate the cost and volume of another similar tank. This chart is also applicable to drums of the same diameter and internal pressure as well as spheres. This is another gem for your working notebook. Turn to **Page 200.**

☐ **Use Lead to Control Refinery Corrosion . . .** Here are the latest practices related to lead construction. Mechanical troubles are responsible for the greater part of the difficulties experienced with lead lined equipment. For details on how to avoid these problems, turn to **Page 201.**

☐ **How Much Nitrogen in Crudes From Your Area? . . .** Nitrogen in crude oils is becoming an increasing problem in catalytic processing. Here is a complete survey showing the nitrogen content of United States crude oils. Check your districts past and present by turning to **Page 207.**

☐ **Technical Writing Isn't Easy, But . . .** At last, here is an article which recognizes there are difficulties involved with technical writing that belong to no other. In normal everyday language, precise details tend to make writing vivid. Technical words such as isooctane are also specific, but they evoke no visual image. Here is a procedure, however, which will help make your reports more readable. Turn to **Page 253.**

☐ **$1 Million Investment in the Future . . .** Your acceptance of Petroleum Refiner has made it possible for the magazine to set new records in circulation and advertising since 1952. You, the subscriber, have been the key factor in our growth, so we want to share this outstanding example of our progress with you on **Page 256.**

☐ **Survey Can Reveal Supervisor Training Needs . . .** One sure way to determine what training your supervisors need is by use of a survey. Here are the different types of surveys that you can use to do the job for you, an outline of how to go about it and who else you should survey to do a bang-up job. Turn to **Page 260.**

Petroleum Refiner

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# Who's YOUR Man?

JUST THIS SIDE of PR's back cover, the green "cardboard" page so popular with New Equipment fans, shows up with a third postcard which seeks an answer to the question "Who's YOUR Man?"

In its January 1959 issue PETROLEUM REFINER will set aside several pages of its Oil Centennial Section and thereon will be listed 12 or 15 or 20 men who have made the greatest contribution to the oil, gas and petrochemical processing industry. The full detail is set forth on Page 164 of this issue. Read that page, give the matter some serious thought and then fill out the postcard and mail. We want a broad, comprehensive list of eligibles so that those finally chosen will truly fill the bill.

# Look What's in May!

OLD TIMERS WILL TELL you about V. O. Marshall's *"Foundations for Stacks and Towers,"* a design article published first in 1939 by PETROLEUM REFINER and because of its value republished two years later. The demand persisted and in the early '40s we came out with a reprint which sold like those hotcakes you've read about all your life. Well, we're going to do it again. Nearly every week we turn down orders for reprints the supply of which has long since been exhausted. Copies of the article used by engineers throughout the industry have been photostated for benefit of others and many of these are in pretty sad state. So, with the help of Author Marshall, we are revising the presentation which will occupy a prominent spot in our May issue. We'll miss our guess in a big way if these 16 pages aren't grabbed—and fast—by readers of PR. It would be a great time, of course, for the grabbers to get on the subscription list. Truly *Foundations* is a valuable work instrument.

# New Ones and Old

PR's REPRINT business is looking up. Permit this Page Fiver with a few details:

- The popular *Disaster Planning*, printed recently as a special report, is now available as a separate. It blueprints in detail how a refinery should plan in advance the procedures that pile up in a single moment when disaster strikes. Price $1 per copy.
- The most reliable information available for design of *Perforated Trays*, as presented recently by C. J. Huang and J. R. Hodson includes many handy work sheets that will speed up these calculations. Another $1 item.
- Two others maybe you've heard about: 1) the F. A. Zenz series on *Fluid Catalyst Design Data* which gathers together in up-to-date fashion the loose ends on this subject (cost $1) and 2) Section II of Wayne C. Edmister's *Application of Thermodynamics to Hydrocarbon Processing*, also $1. This latter reprint has been out of stock for several years but several hundred copies have recently become available.

For any or all, send cash with order to Reprints, PETROLEUM REFINER, Box 2608, Houston 1, Texas.

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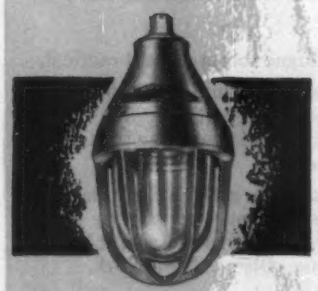

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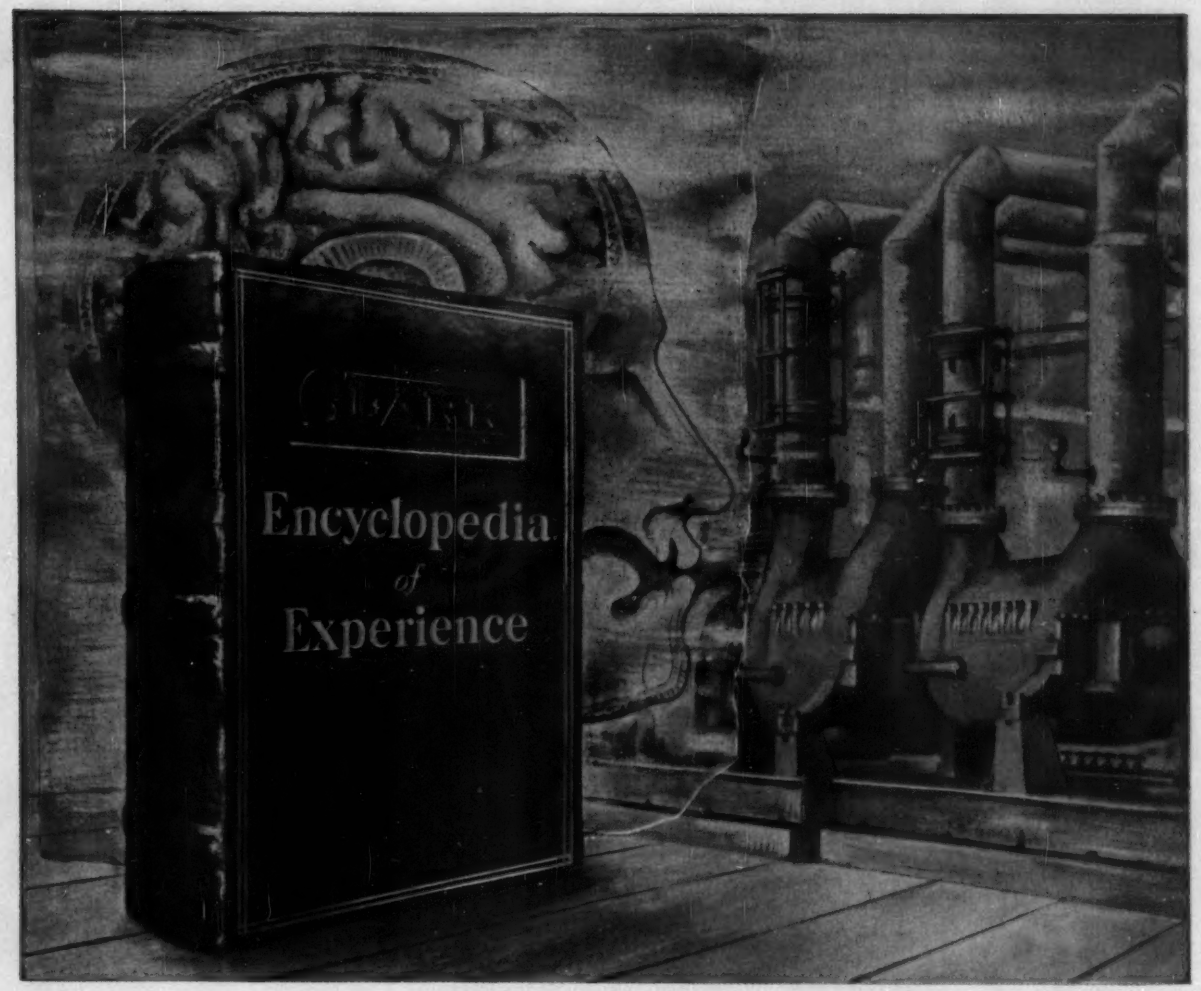


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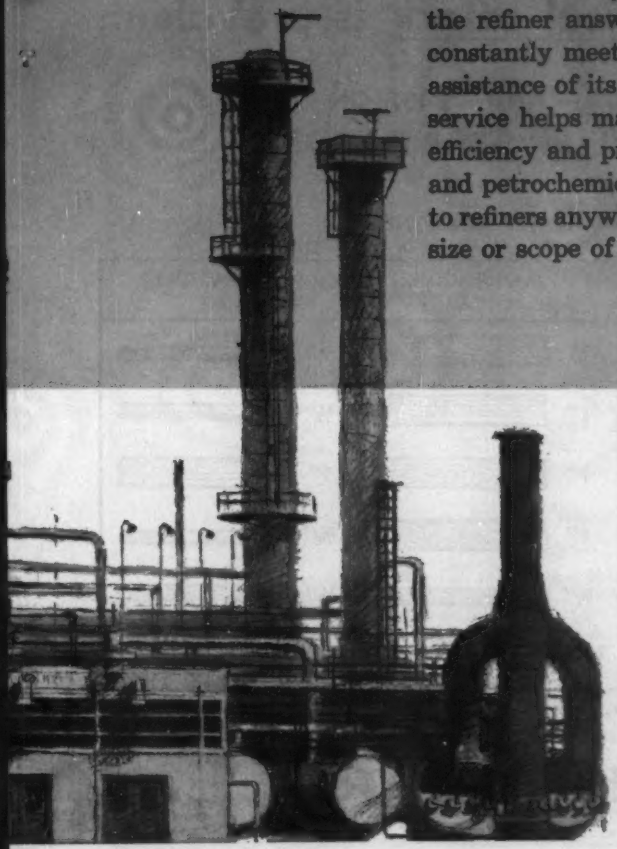

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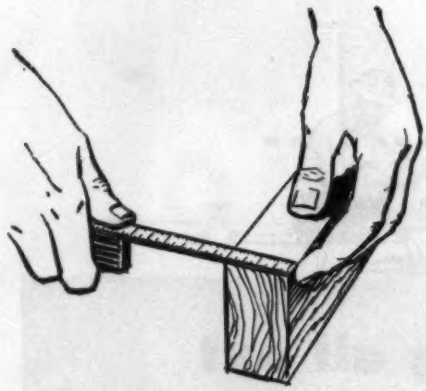

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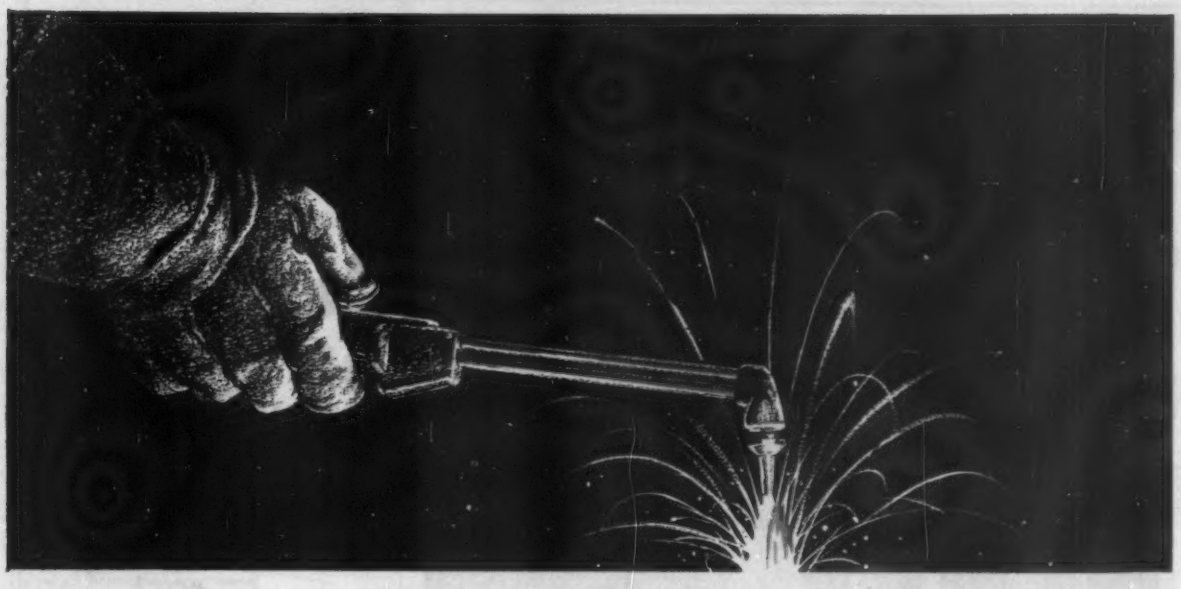

# ACETYLENE

## ...bright future for an old flame!

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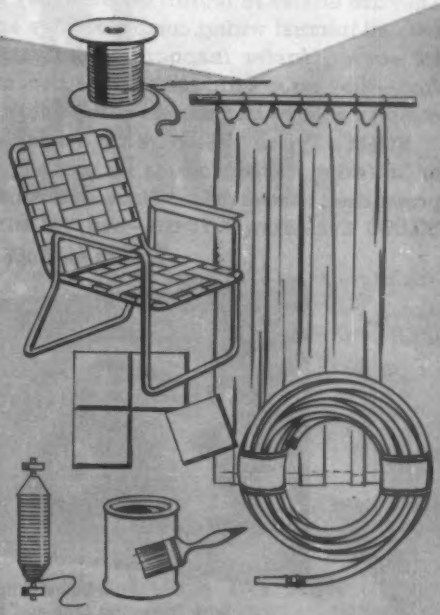
*If you are interested in the profit making opportunities offered by acetylene, we suggest you send for CHEMICO's new acetylene brochure (Bulletin No. 257), which will give you more detailed information on the BASF process and CHEMICO's experience in this field.*



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**CHEMICO**

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*PRESSURIZED ROOMS*
*OUTDOORS*
*INDOORS*

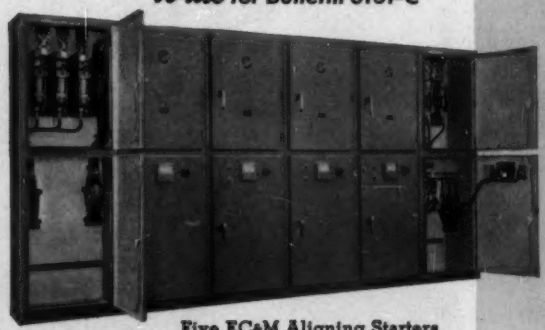
*left* • Type AH Starter (50,000 KVA, certified) for Division 2 Applications. NEMA 3R (raintight) Enclosures for mounting outdoors

*below* • Diesel loading pump station in southwestern refinery

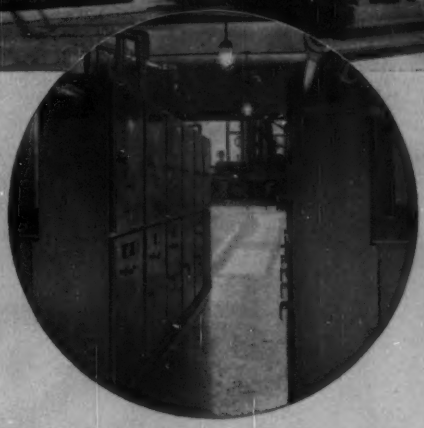
• EC&M Starters are standardized for *easy selection.* They are *easier to install* because they are shipped with all internal wiring complete. They are designed for *easier, faster inspection and maintenance.* And—they *save valuable space* because they are compact with no sacrifice in accessibility.

EC&M's Type AH Starters are available in NEMA 1 or 3R (raintight) enclosures for outdoors, indoors or pressurized control rooms. Three interrupting ratings: 50,000 KVA—POWER FUSED—and VALIMITOR®

***Write* for Bulletin 8131-C**



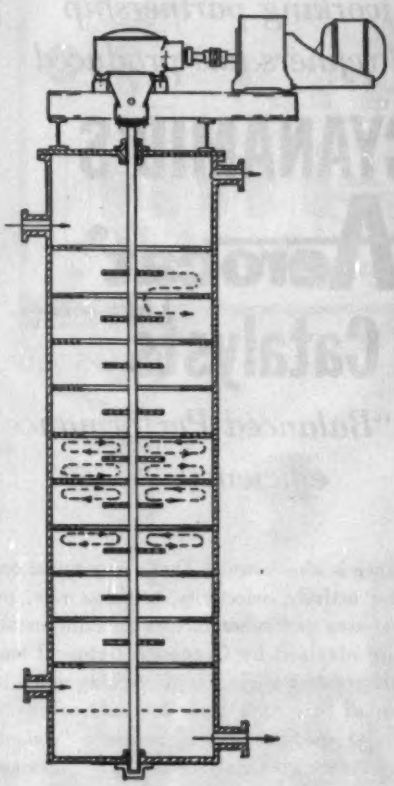
Five EC&M Aligning Starters with Incoming Line and Feeder Panels for Pumps and Compressors (Pacific Coast Refinery)



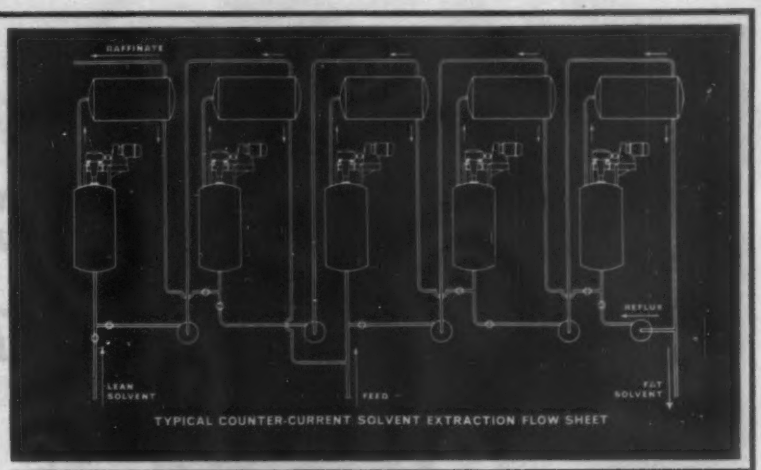
Pressurized Control Room with ten NEMA 1 EC&M Enclosed Starters in midwest refinery

**THE ELECTRIC CONTROLLER & MFG. CO.**
*A DIVISION OF THE SQUARE D COMPANY*
CLEVELAND 28 • OHIO

8019



TURBO-MIXER R.D.C. COLUMN
Licensed Under
Shell Development Company Patent




TYPICAL COUNTER-CURRENT SOLVENT EXTRACTION FLOW SHEET

# call on TURBO-MIXER for SOLVENT EXTRACTION

**Whether you are extracting uranium with mixer settlers (like Kerr-McGee and Vitro) or butadiene (like Esso Standard or Polymer Corporation) or a continuous counter-current extraction column (like Bakelite), there's a Turbo-Mixer designed exactly to meet your needs.**

**Turbo-Mixers are designed for maximum service, based on over 40 years of experience and specialization in mixer construction. For descriptive information showing how your problems may be solved by Turbo-Mixer, write today.**

**FOR DETAILED INFORMATION AND USEFUL DESIGN DATA, SEND FOR THE FOLLOWING BULLETINS:**

**Please send me the following Turbo-Mixer Bulletin (s):**

**General Turbo-Mixer Bulletin_____**

**RDC Extraction Column Bulletin_____**

**Side Entering Propeller Mixer Bulletin_____**

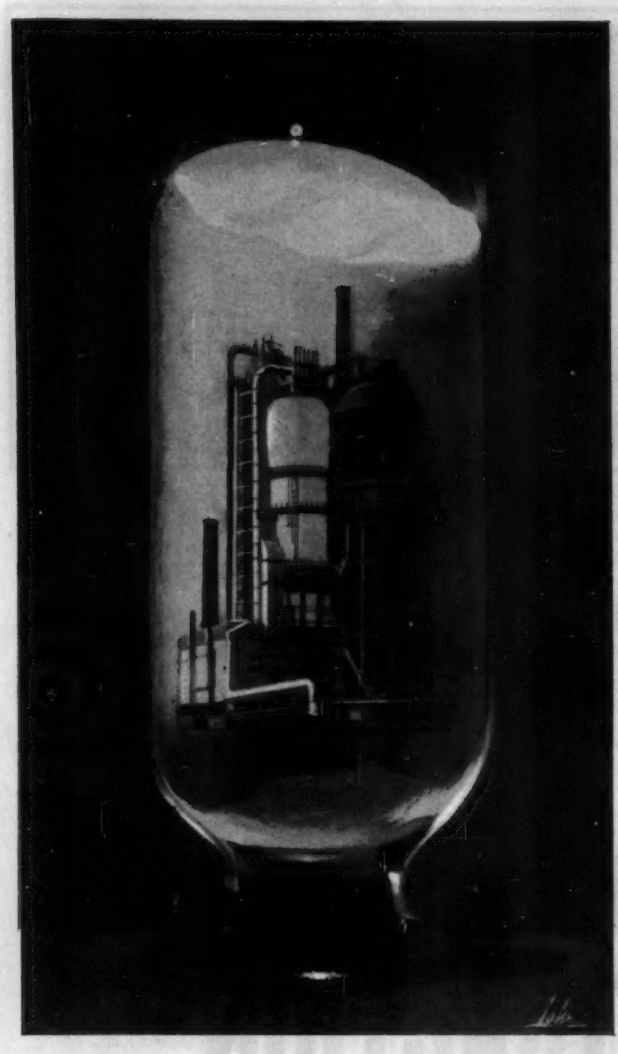
**Absorption & Oxidation Bulletins_____**

**TURBO-MIXER DIVISION**
**GENERAL AMERICAN**
**TRANSPORTATION**
**CORPORATION**

**Sales offices: 380 Madison Avenue, New York 17, New York • General Offices: 135 South LaSalle Street, Chicago 90, Illinois • Offices in all principal cities**



**For more data on advertised products, use Readers' Service Cards, last page.**



*A working partnership with refiners has produced*

# CYANAMID'S Aerocat® Catalysts

*...with "Balanced Performance" efficiency*

*Field* performance is what counts! That's why actual *operating* values for activity, selectivity, attrition rate, pore volume, surface area and other factors affecting catalyst performance are obtained by Cyanamid technical teams working with the refinery engineers of cracking units. It is the evaluation of this data that determines current Cyanamid catalyst specifications to insure a *"Balanced Performance"* — AEROCAT Catalysts that give maximum over-all efficiency in refinery use.

Your Cyanamid representative can provide extensive data relating to the use of AEROCAT Catalysts in *your* cracking operations.

## PROBLEM-SOLVING MUD CONDITIONERS

High stability at elevated temperatures, or in the presence of contaminants, makes CYPAN® Drilling Mud Conditioners ideal for even difficult drilling operations. This high molecular weight acrylic-type polymer is effective even at high dilutions — has outstanding fermentation resistance and is unsurpassed in duration of water-loss control.

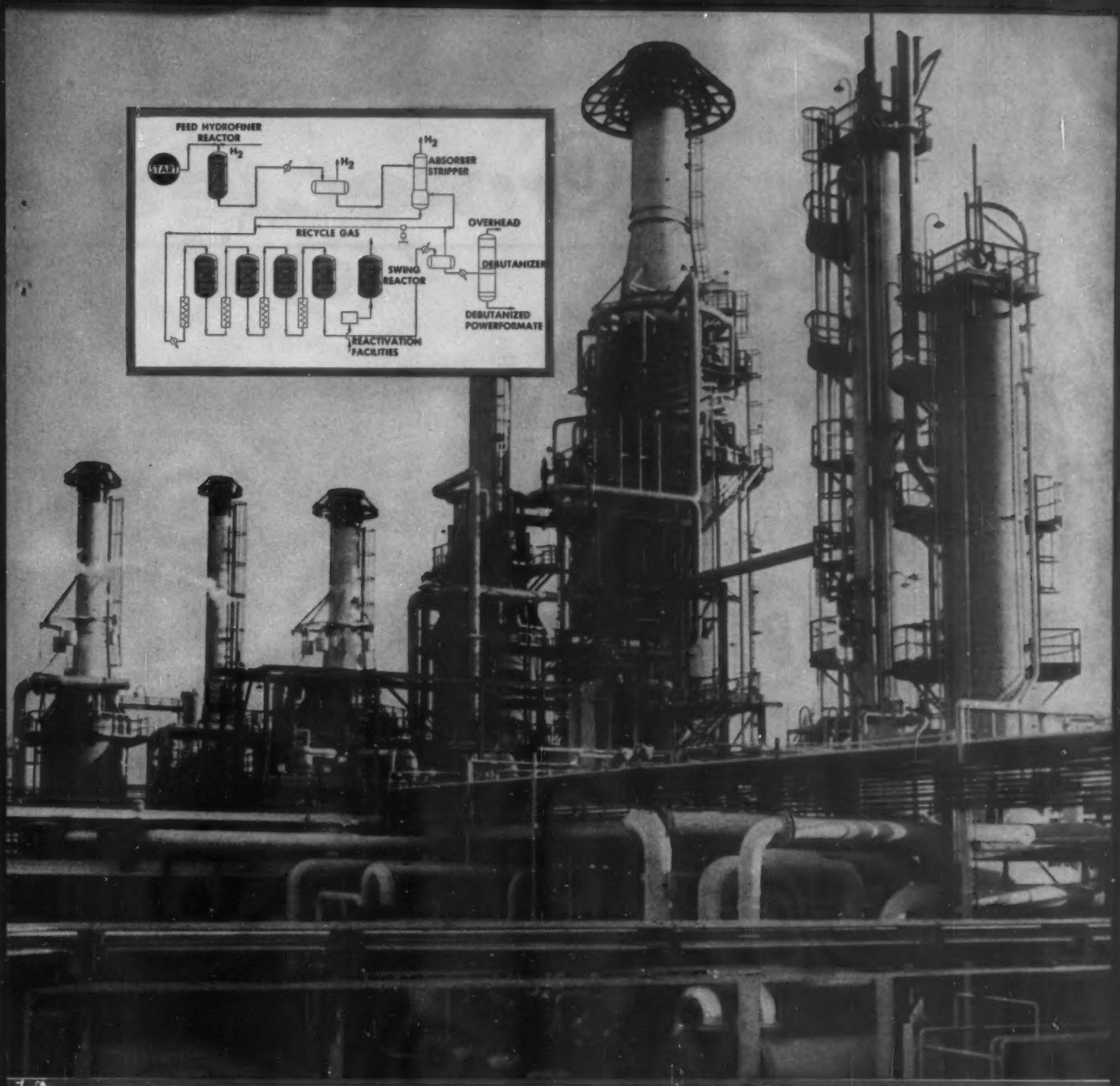
## PLATINUM CATALYSTS BOOST OCTANE

Even low naphthene stock responds to the excellent catalytic action of AEROFORM® PHF Platinum Reforming Catalysts. These highly refined platinum-promoted alumina base catalysts are highly selective, regenerate easily and provide high octane levels with each reforming process.

CYANAMID

**AMERICAN CYANAMID COMPANY, REFINERY CHEMICALS DEPARTMENT**

30 Rockefeller Plaza, New York 20, N. Y. • In Canada: Cyanamid of Canada Limited, Montreal and Toronto




# POWERFORMING PROCESS CAN INCREASE YOUR HIGH OCTANE YIELD

Esso Research and Engineering Company offers you *Powerforming*, the most versatile platinum reforming process ever developed. *Powerforming* is another achievement of the Esso Research program — 38 years of new process developments which have been made available to refiners around the world.

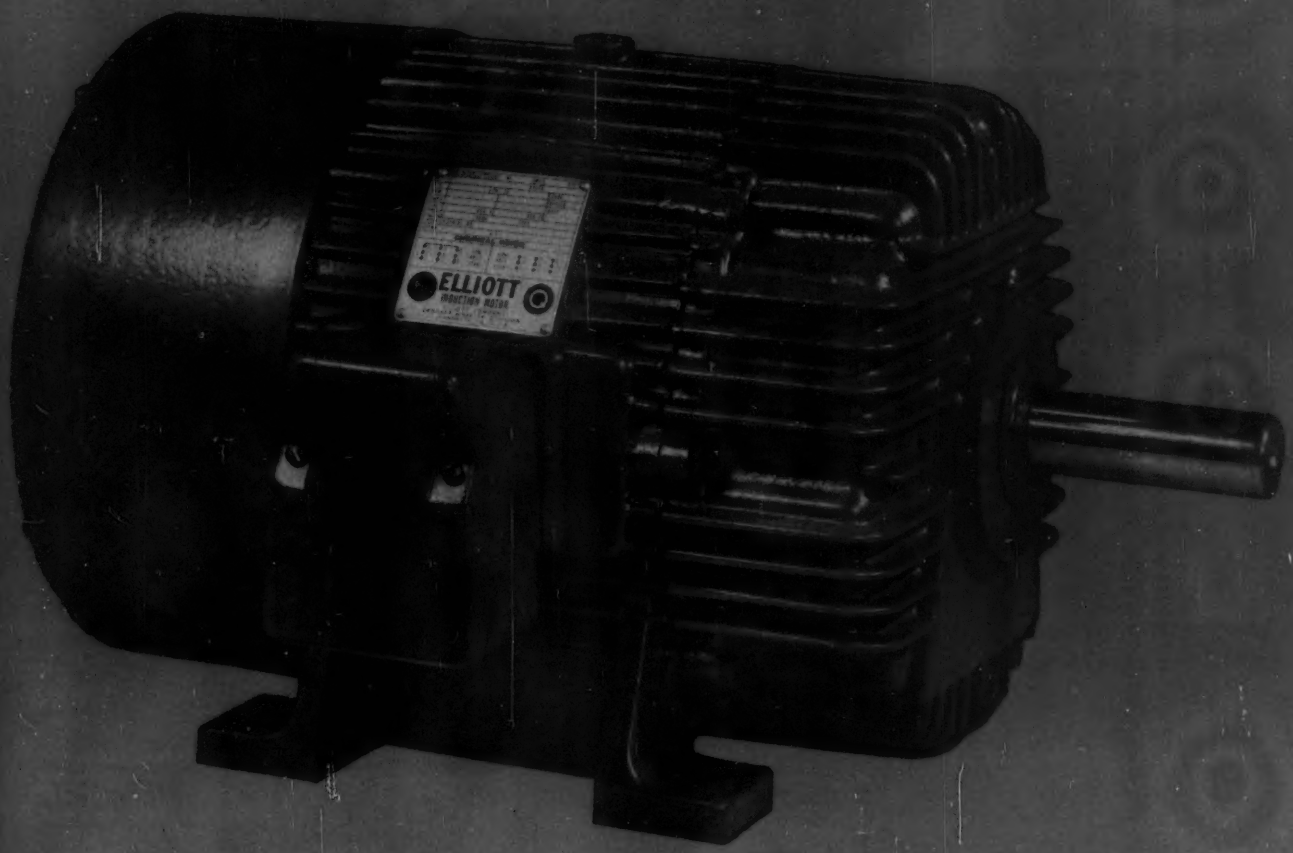
Heart of the *Powerforming* process is a new, more active platinum catalyst. High activity over a long life is assured by significant new regenerative techniques. With this new process, good yields of 100 octane clear Powerformate can even be obtained from paraffinic stocks. Twelve *Powerforming* installations are on stream; twenty-one are in the planning or construction stage. Licensees enjoy benefits of continuing *Powerforming* research. We would welcome your inquiry on the part *Powerforming* can play in *your* modernization plans.

**ESSO RESEARCH AND ENGINEERING COMPANY**

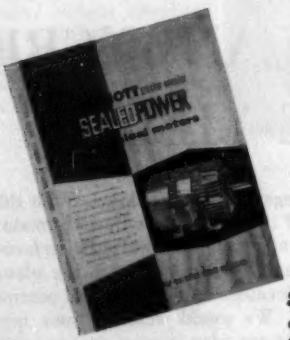
*P.O. Box 243, Elizabeth B, N. J.*

*Your key to progress... an Esso Research process*

# Protected




W2-9




## ELLIOTT Company

*Crocker-Wheeler Division* • **JEANNETTE, PENNSYLVANIA**

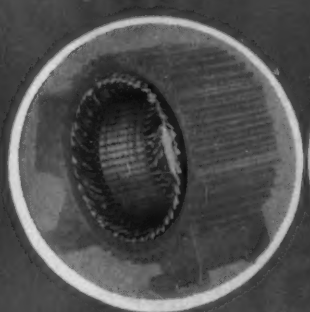
***Send for*** **new bulletin PB 6000-8, describing the remarkable Elliott Sealedpower C-W Chemical Motors.**

# against corrosion

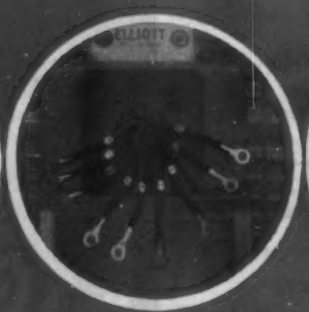
## new ELLIOTT C-W sealedpower chemical motor

Thoroughly protected against corrosive vapors, gases and moisture, the new Elliott C-W totally-enclosed Chemical Motors are designed to serve dependably under conditions that would incapacitate other motors. Every vulnerable point has been sealed or armored. The frame, brackets, fan cowl and conduit box are corrosion-resistant cast iron. The external fan is made of either cast bronze or cast aluminum (choice depending upon service conditions), with a split hub, keyed to the shaft. The windings are given special chemical-resisting treatment with siliconized varnish, providing a tough surface that resists acids, alkalies and moisture. A rotating slinger on the motor shaft effectively prevents the entrance of moisture and foreign matter. Leads are sealed by tightly-packed grommets. Nameplate is Monel and external hardware is heavily plated.

**SOME OF THE PROTECTIVE FEATURES OF ELLIOTT CHEMICAL MOTORS**

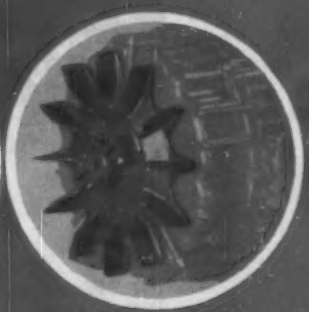


Windings have special chemical-resisting insulation.



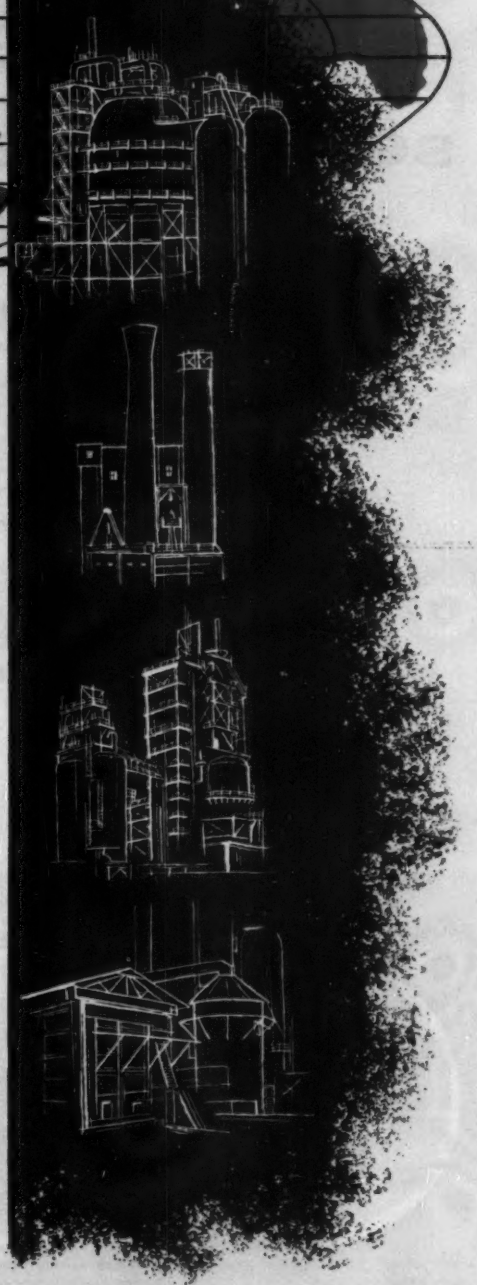
When conduit box is mounted, grommet is tightly compressed, sealing the point where leads pass through the frame.

A rotating slinger guards the shaft opening against the entrance of moisture or foreign matter.



Cast bronze or aluminum external cooling fan is firmly attached to the shaft by both a key and bolted split hub. Safe against loosening and corrosion.

# THROUGHOUT THE WORLD...



**Serves the Petroleum Refining Industry with a Complete Line of High Quality Refractory Products**

The petroleum industry, throughout the world, relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, et cetera.

A world-wide network of A. P. Green distributors with engineers experienced in petroleum refining is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. For one dependable source of a complete line of refractories write . . .

A. P. Green
REFRACTORY PRODUCTS

**A. P. GREEN FIRE BRICK COMPANY**
Mexico, Missouri, U. S. A.

**PLANTS:** Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas • Jackson, Oak Hill, South Webster, Ohio • Philadelphia, Pa. • Troy, Idaho

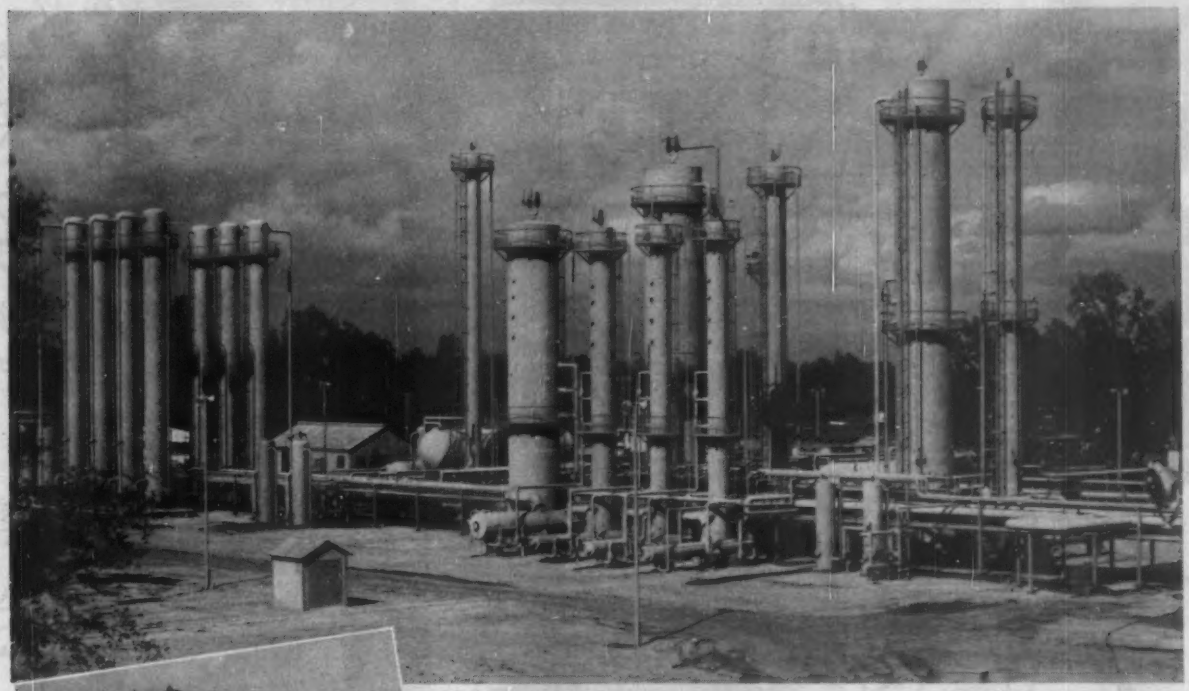
*In Canada:* A. P. GREEN FIRE BRICK COMPANY, LTD. Toronto 15, Ontario

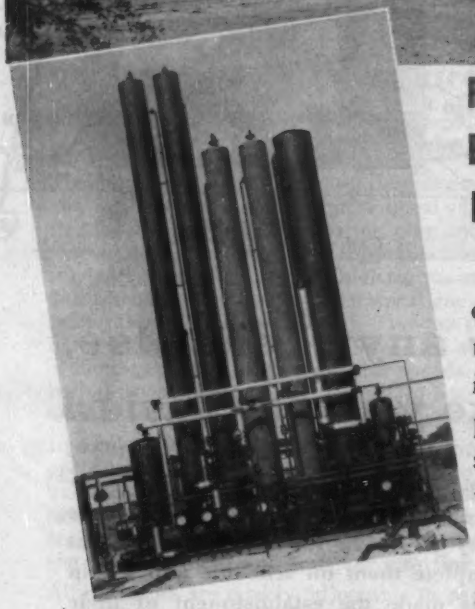
*In England:* LIPTAK, LTD. London, England

*Distributors in the Principal Cities of the World*

FLINT

# *for a complete plant or a package!*





## FLINT fabricates PROCESS EQUIPMENT for the petroleum and chemical industries

The combination of sales, engineering and estimating, detail drafting, materials storage and the facilities of two large and modern manufacturing plants enable Flint to complete a project of practically any size. Flint also has radiograph and stress relieving equipment — furnace is 15′2″ wide and 85′ long.

Flint fabricates carbon steel, stainless steel, monel and non-ferrous metals in compliance with API-ASME or the ASME CODE for Unfired Pressure Vessels.

**Such PRODUCTS as:**

**Pressure Vessels**
**Fractionating Columns**
**Bubble Caps**
**Bubble Trays**
**Heat Exchangers**

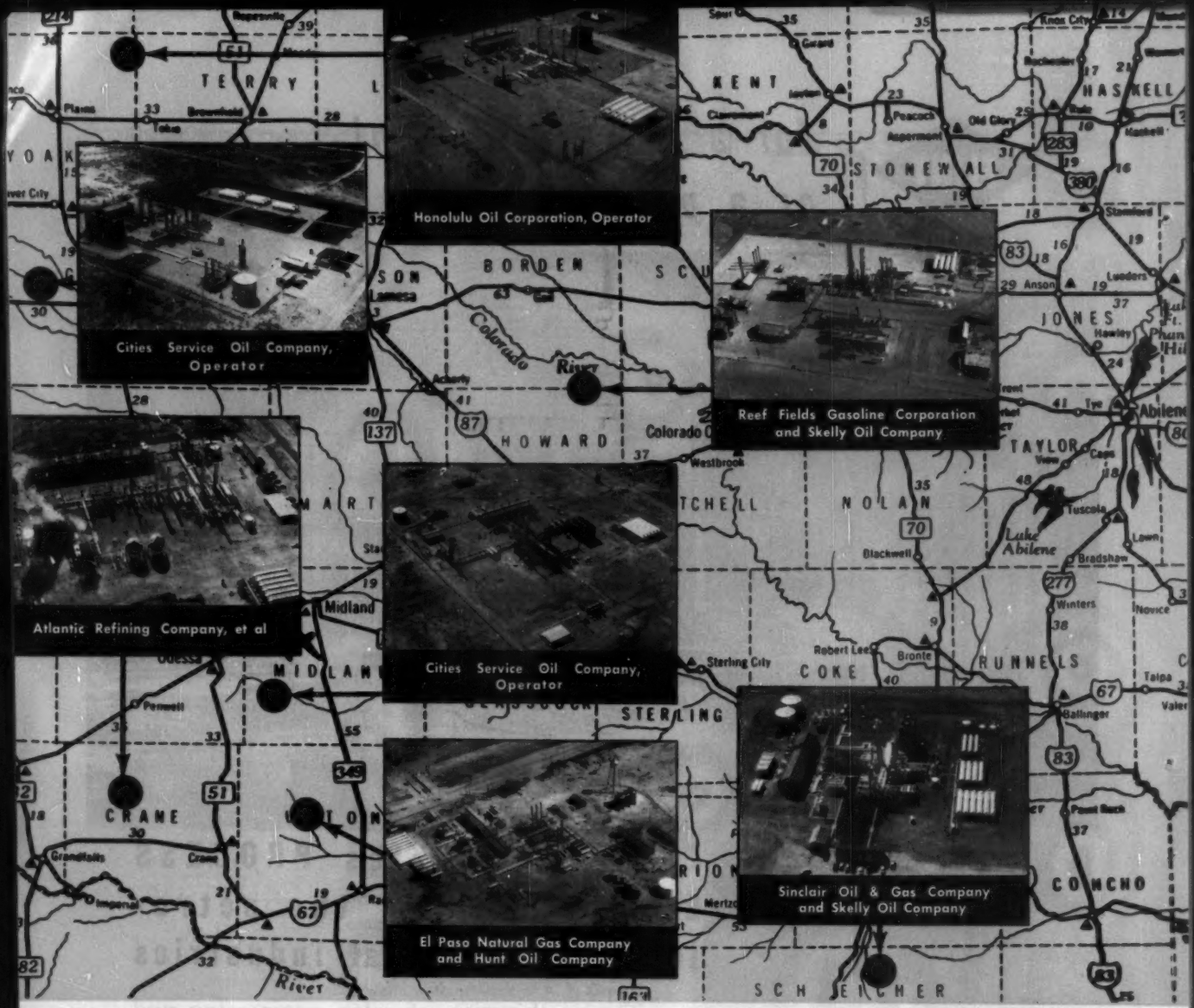
STEEL PLATE FABRICATORS ASSOCIATION FOUNDED 1933

## FLINT STEEL CORPORATION

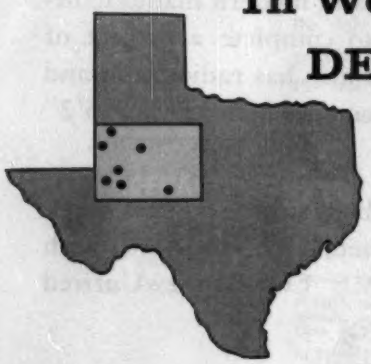
**TULSA • MEMPHIS**



For more data on advertised products, use Readers' Service Cards, last page.


Honolulu Oil Corporation, Operator
Cities Service Oil Company, Operator
Reef Fields Gasoline Corporation and Skelly Oil Company
Atlantic Refining Company, et al
Cities Service Oil Company, Operator
Sinclair Oil & Gas Company and Skelly Oil Company
El Paso Natural Gas Company and Hunt Oil Company

# In West Texas, or anywhere else, DELTA can make your job easier!

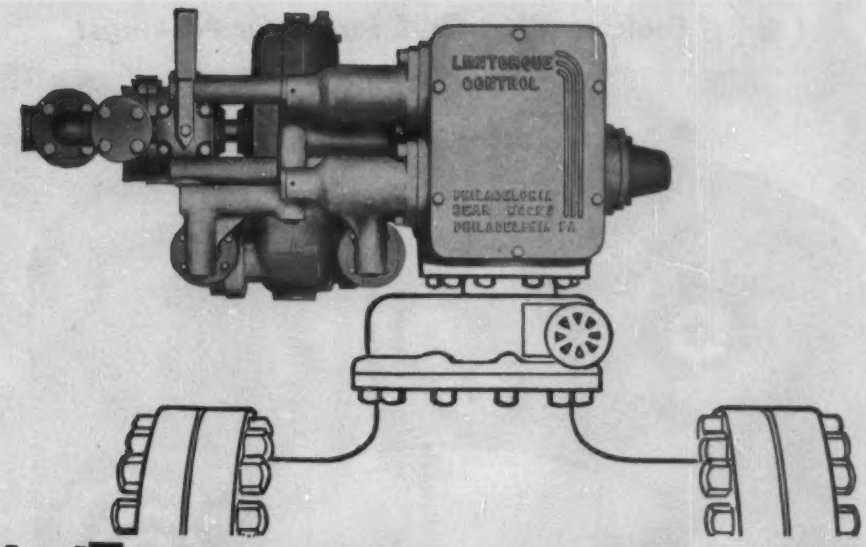


**These customers in West Texas have experienced the value of using Delta design-engineers and crews. They have found that Delta's ability to design facilities to operate at minimum costs and complete them on schedule and within the assigned budget, has made the establishment of their plants much easier.**

**You, too, will find that it is to your advantage to consult with Delta Engineering Corporation *first*—for, from preliminary planning to plant dedication, regardless of location, Delta can make your job easier.**

DESIGNING ENGINEERING DELTA CONSTRUCTION

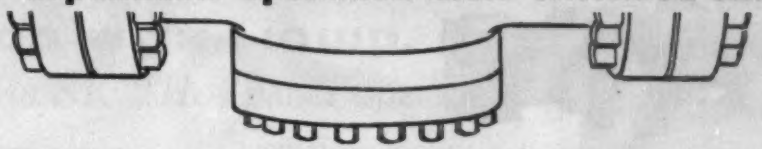
**DELTA ENGINEERING CORPORATION**
***Engineering Contractors***
**2121 San Felipe Rd. • P. O. Box 13256 • Houston, Texas**




# LimiTorque TYPE "GAS" VALVE CONTROLS

## ...feature the only true turbine design available

## ...provide dependable operation after extended shutdown



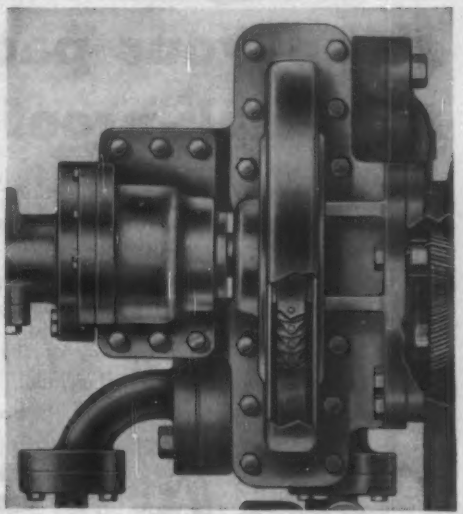
### *exclusive design features include:*

- **Positive, simple overspeed control**
- **All internal parts of non-corrosive materials**

The type GAS valve operator introduces an entirely new concept into automatic mechanical valve operation. Here is a motorized operator for plug and gate valves especially designed for natural gas pipeline service. The single wheel turbine develops high torque at rated speeds and is designed to operate on natural gas at unreduced inlet pressures up to 1200 psi. The gas turbine eliminates serious friction wear at vane tips and possibility of damage due to excessive motor speeds. Being a true turbine, with permanently lubricated bearings, no line oiler or any other lubrication means is required.

In some sizes of gate valves the LimiTorque type GAS operator is top mounted, eliminating the expense of valve bevel gearing. A declutching mechanism disconnects the motor, allowing a complete checkout of the entire system. The turbine can be run without moving the valve or disturbing limit valve settings.

All operators are readily adjustable to packaged automatic shutdown systems, solenoid control and manual control through the use of four way valves. Electrical switches can be provided for remote light indication.



Cutaway shows unique single wheel turbine construction.

**LimiTorque®**

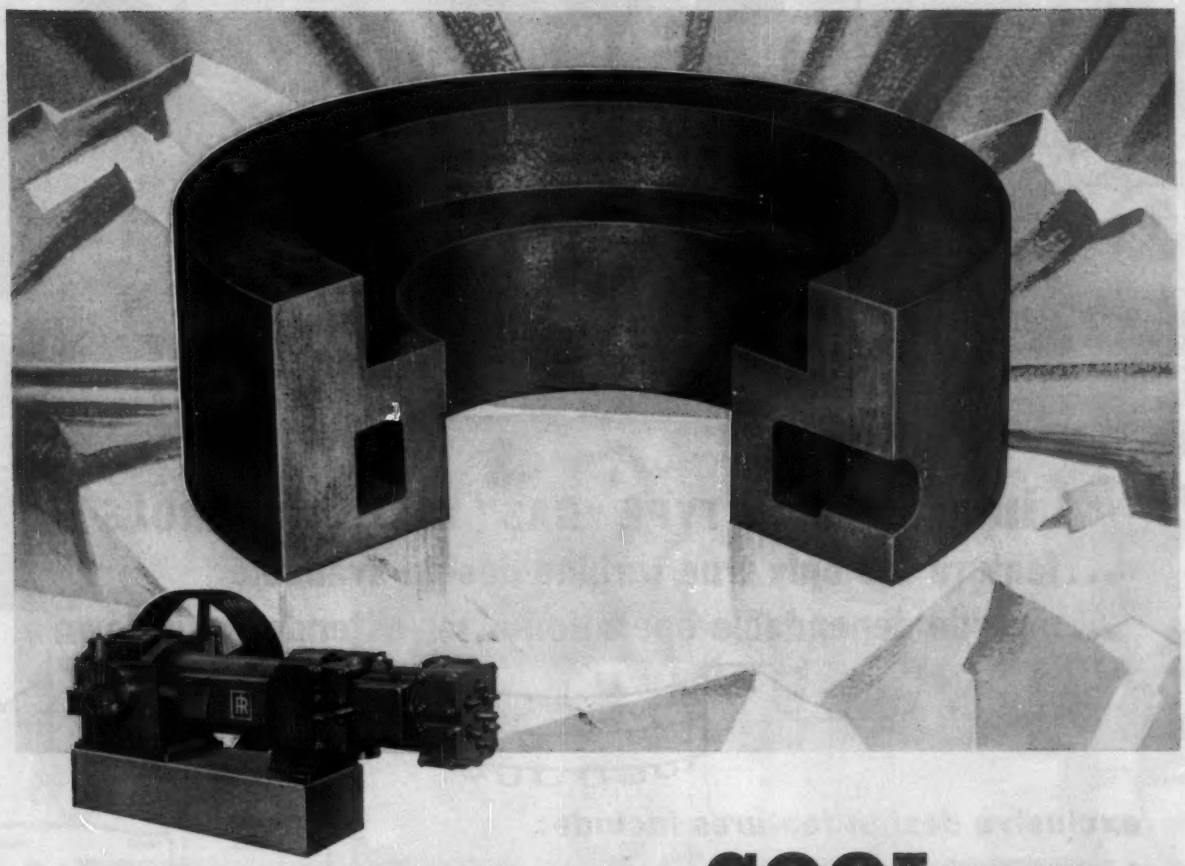
PHILADELPHIA GEAR WORKS, INC.
ERIE AVE. & G STREET. PHILADELPHIA 34, PENNA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS
Limitorque Corporation • Philadelphia



For more data on advertised products, use Readers' Service Cards, last page.

Look to **COOK** for Better Packings!

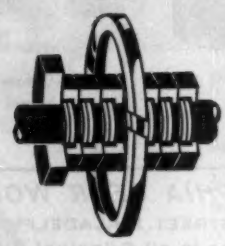


# Keep your packing COOL with this leak-proof Cook packing cup!

CHANCES are you've never seen anything like Cook's water-cooled packing cup, as shown above with one of Ingersoll-Rand's new ESH compressors. That's because it's new, *with a leak-proof construction that's exclusive with Cook!*

Water circulates around the *inside of the cup itself*, in a completely self-contained channel. This eliminates any possibility of leakage, corrosion, or contamination of the material under compression. These are big advantages for all applications —and are naturally of even *greater* importance for non-lubricated service.

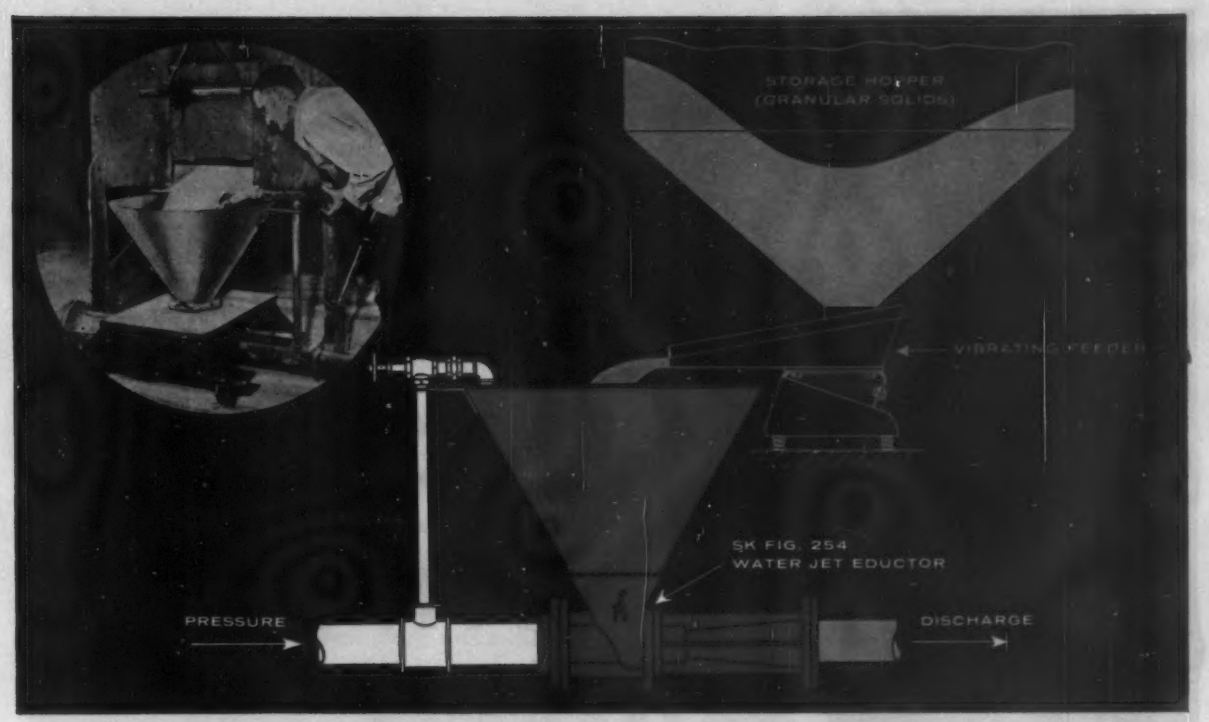
Write direct today for full details about this revolutionary new water-cooled packing cup. Address: C. Lee Cook Company, 950 South Eighth Street, Louisville, Kentucky.



**C. LEE COOK COMPANY**

Division of Dover Corporation

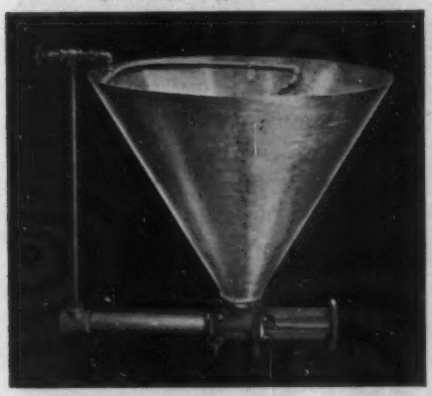
*Rings and Packings Since 1888*




# MIX SOLIDS WITH LIQUID, CONVEY SLURRIES

## *with this SK "Hopper Type" Water Jet Eductor*

SK Fig. 254 Hopper Type Water Jet Eductor



**SK's Hopper Type Eductor, shown above and at left, will mix solids with liquid and convey slurries conveniently and at low cost. See box below for types of granular solids currently being handled.**

**An inexpensive unit, this light-weight eductor is easy to install, simple in construction with no moving parts, requires little maintenance, and provides efficient service over long periods. In operation, pressure water, issuing through the nozzle, entrains granular solids from the hopper and discharges through discharge piping. Agitating jets keep material moving down into the eductor.**

**Used in the petroleum industry, in chemical processing and food processing plants, the hopper eductor has proved to be extremely satisfactory in handling the materials (bulk densities noted) listed below and others.**

**For full details on Hopper Type Eductors including sizes, capacities, ratios, water consumption, materials of construction, write to SK for Bulletin 2M.**

**SK HOPPER EDUCTORS ARE BEING USED CURRENTLY TO HANDLE THE FOLLOWING MATERIALS** *(Approx. Bulk Densities Indicated in Parentheses)*

| | | |
|---|---|---|
| Borax (50-55) | Fly Ash (35-40) | Sawdust, Dry (13) |
| Charcoal (18-28) | Rosin (67) | Soda Ash, Light (20-35) |
| Diatomaceous Earth (10-20) | Salt, Granulated (45-51) | Sodium Nitrate, Dry (80) |
| Lime, Pebble (56) | Salt, Rock (70-80) | Sulphur, Powdered (50-60) |
| Lime, Powdered (32-40) | Sand, Damp (75-85) | Wheat (48) |
| Mash (60-65) | Sand, Dry (90-100) | Zinc Oxide, Powder, Dry (10-35) |

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

**Schutte and Koerting**
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2257 State Road, Cornwells Heights, Bucks County, Pa.



For more data on advertised products, use Readers' Service Cards, last page.

# What do you want in WELDING FITTINGS?

For any welded piping job you want fittings that fit — no disgusting last-minute complications.

You want fittings made of materials that measure up to your specifications — no mysterious failures.

You want a source for special as well as regular fittings. You want to avoid unnecessary welds, makeshift expedients, clumsy combinations.

You want to avoid procurement ordeals — the business of trying to make yourself understood. You want to do business with alert men who speak your language — engineers if you need them.

And — you want to know your business is appreciated.

The best answer to your welding-fittings wants, of course, is in your nearby J&L Supply store.

**Jones & Laughlin**

**SUPPLY DIVISION** – Tulsa

J&L — A GREAT NAME IN SUPPLIES

# new chemical plant
# DESIGNED AND BUILT IN JUST SIX MONTHS

**Undivided responsibility for engineering, procurement and construction services enabled CATALYTIC to build a new, operating chemical plant in just six months!**

**This unique performance called for precise coordination between the client and the contractor—to CATALYTIC, this project was a welcome opportunity to meet the challenge of on-time, on-budget performance . . . to show SKILL, EXPERIENCE and IMAGINATION at work.**

# CATALYTIC
## CONSTRUCTION COMPANY

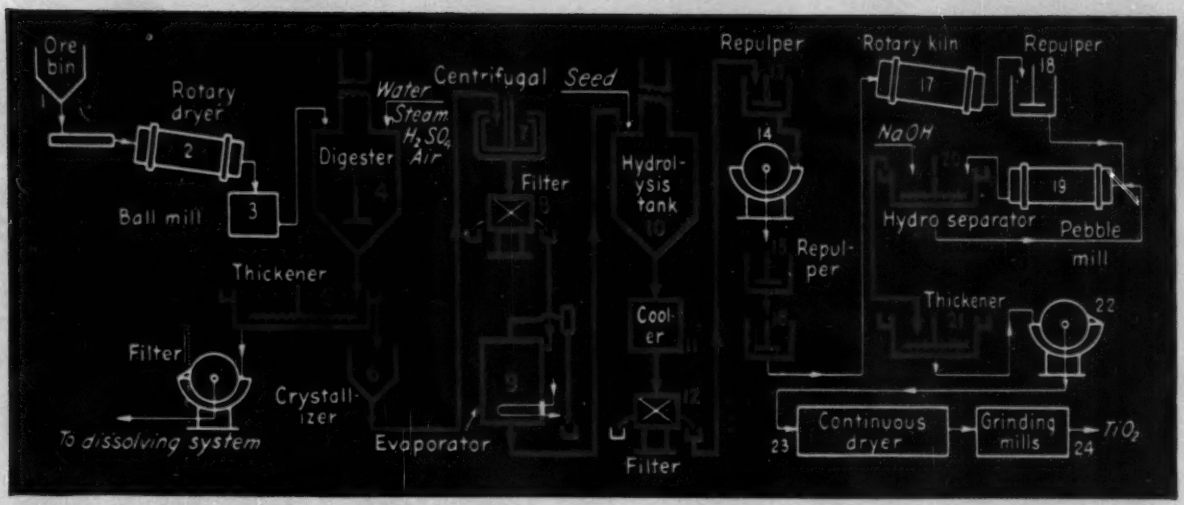
**Philadelphia 2, Pennsylvania • Toledo, Ohio**

**In Canada:** Catalytic Construction of Canada, Limited; Sarnia, Ontario; Toronto, Ontario; Montreal, Quebec.

**Catalytic *On-Time...On-Budget* Services** for the metallurgical, chemical, petrochemical and oil refining industries: Project Analysis; Process Development; Process Design; Economic Studies; Engineering; Procurement; Construction.



For more data on advertised products, use Readers' Service Cards, last page.




# How *lead is used to control corrosion in Titanium Dioxide Production Equipment*

$TiO_2$ is not corrosive. But $H_2SO_4$ is a real metal-eater . . . *first* on the attacking line in the production of $TiO_2$.

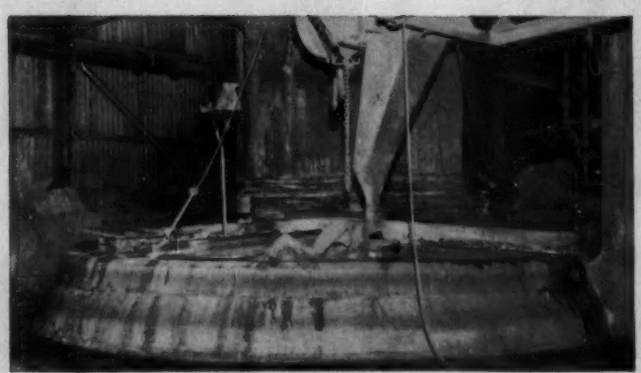
*First* on the defensive line, however, is *lead*, dependability itself when it comes to combating many corrosive chemicals.

*Lead* reacts on contact with $H_2SO_4$ and other "corrosives" to form an insoluble, impermeable film. This film adheres to the metal surface . . . stopping or slowing down further reaction or attack.

Starting with digesters, where ilmenite ore is treated with sulphuric acid, *lead* is a steady defender . . . as lining for vessels and tanks, valves and pumps, in heating and cooling coils, in centrifugals and filters. It is used in combination with steel, concrete, wood or brick in many of the steps in the manufacture of $TiO_2$.

And bear this fact in mind: the use of *lead* cuts down-time. *Lead* lends itself to prompt, low-cost repairs. In case of leak or lesion, the affected area may be fixed quickly, with minimum loss of production. And . . .

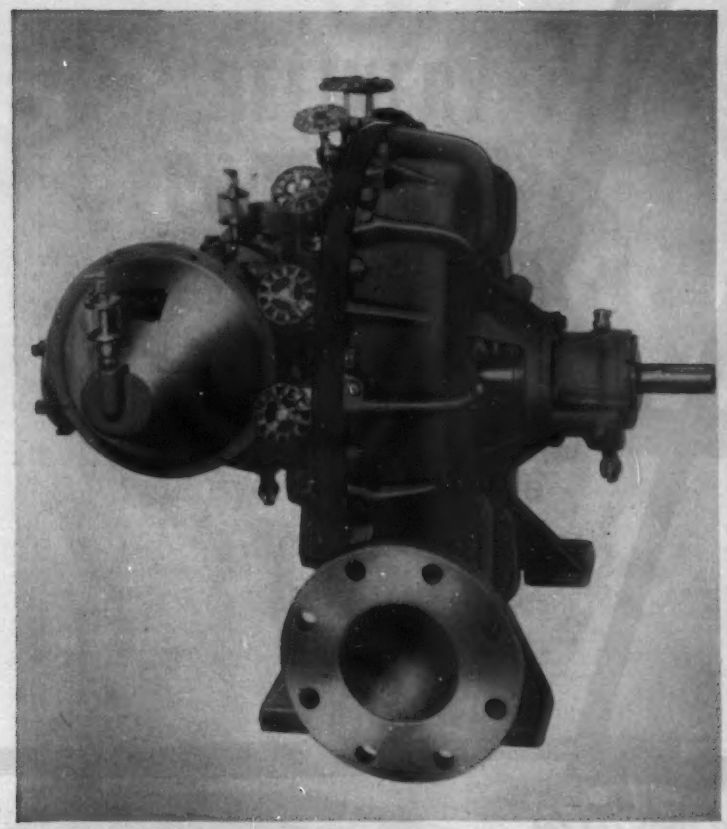
## . . . when you think of Lead . . . think of National Lead



National Lead's long experience in bringing *lead* and steel together . . . in acid-handling lines, in complex, massive process, storage and shipping vessels . . . is at your service. When *lead* and steel are bonded together in this equipment, the union is stronger than *lead's* tensile strength. Cracking of the lining, due to vibration, pressure and rapid cyclic temperature changes, is held to a minimum. Creep is virtually eliminated.

Perhaps *lead* can save you money. Contact National Lead Company, Lead Lined Products, 111 Broadway, New York 6, N. Y., for information.


For more data on advertised products, use Readers' Service Cards, last page.



*This is the reliable Coppus Turbine furnished with either type of wheel*

*Wide bucket "L" type wheel*

*Regular type wheel*

# *Top performance in all* COPPUS TURBINES

Both the regular type wheel or wide bucket "L" type wheel give you Coppus proven high quality and low maintenance cost. The "L" type wheel is the new development for use where low water rate is essential.

Coppus "Blue Ribbon Turbines" earned their fine reputation right on the job. Users vouch for their top quality performance and their low maintenance cost.

In the words of the supervisor of a large chemical company: "Coppus turbines require so little maintenance that a person would starve to death, if he depended on it for a living."

Proven features of *all* Coppus Turbines:

- Turbines rated close to your hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, *make turbine dollars go farther*. Send for Bulletin 135 on Coppus Turbines.

COPPUS ENGINEERING CORPORATION
417 Park Avenue, Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

**COPPUS "BLUE RIBBON" TURBINES**



For more data on advertised products, use Readers' Service Cards, last page.

LUBE

# REFINERY PRODUCTS FUNCTION BETTER

when you add versatile
Armour Duomeens®

There seems to be no end to the versatility of the Duomeens and their derivatives. That's why most of America's major refining companies are today using these oil-soluble, cationic chemicals as corrosion inhibitors in the refining process, as chemical intermediates for making various refinery products—and, of course, for direct use as special additives in the finished products.

Nearly every refinery finished product is benefiting from one of the Duomeens or their derivatives: aviation gasolines, jet fuels, automobile gasolines, #2 fuel oils, diesel oils, lube oils and a variety of greases—to name a few.

The Duomeens function in many ways in the finished products. They are used as outstanding corrosion inhibitors in gasolines, lube oils and greases. They have few equals when used as sludge inhibitors in various fuels and oils. Then too, many oil companies are putting Duomeens into hi-pressure oils and greases where they act as pressure lubricants and oiliness agents. The Duomeens also function as de-icers in gasolines.

The Duomeens are dipolar . . . $R(NH)CH_2CH_2CH_2(NH_2)$ . . . organic surface active agents. They have adsorption characteristics which enable them to form organophilic or hydrophobic films on metal surfaces when used alone—or when reacted with organic or inorganic acids. Reacted, they give varying degrees of water and/or oil solubility, depending on the requirement.

**Chemical and Physical Properties**

| | Duomeen C | | Duomeen T | | Duomeen S | |
|---|---|---|---|---|---|---|
| | Min. | Max. | Min. | Max. | Min. | Max. |
| Iodine Value | 5 | 15 | 32 | 50 | 50 | |
| % Active Duomeen | 83 | | 83 | | 83 | |
| Primary Amine | 35 | 45 | 35 | 45 | 35 | 45 |
| Secondary Amine | 38 | | 38 | | 38 | |
| Moisture % | | 1 | | 1 | | 1 |
| Color—FAC | | 19 | | 19 | | 13 |
| Melting Point 25°C | 20 | 24 | 38 | 43 | 33 | 38 |
| Combining Weight | 304 | 311 | 377 | 386 | 378 | 387 |
| Appearance @ 25°C | Liquid | | Soft Paste | | Heavy Liquid | |
| Specific Gravity @ 25°C | 0.836 | | 0.841 | | 0.846 | |
| Viscosity @ 25°C | 10 cps. | | 880 cps. | | 70 cps. | |
| Viscosity @ 30°C | — | | 70 cps. | | 40 cps. | |
| Viscosity @ 35°C | — | | 10 cps. | | 10 cps. | |

These chemicals have passed industry-wide specification tests such as the steam turbine test, the salt water spray test and others.

Don't overlook the adaptability of the Armeens®. These monopolar . . . $R(NH_2)$ . . . high molecular weight aliphatic amines have many of the same properties that make the Duomeens so popular with refineries.

Armour pioneered the use of fatty amines and diamines in refinery applications. The technical knowledge gained through many years' research and development is now available to you. Our trained staff will help you utilize the right additive for your products, or for your special situation. There is a Duomeen or Armeen—or perhaps one of their derivatives—specifically designed to solve your problem.

**ARMOUR CHEMICAL DIVISION**

©Armour and Company • Chicago 9, Illinois

*Leader in Progressive Fatty Acid Chemistry*

SEND FOR PRODUCT SAMPLES, INFORMATION AND FREE "SLIDE RULE" CALCULATOR

☐ Duomeen Booklet PR-4

Samples of _____
(fill in chemical desired)

Application information on _____

☐ Chemical additive "Slide Rule" Calculator

Name _____

Title _____

Company _____

Address _____

City _____

(Offer limited to North American Continent)

Armour Chemical Division • 1355 W. 31st St. • Chicago 9, Ill.

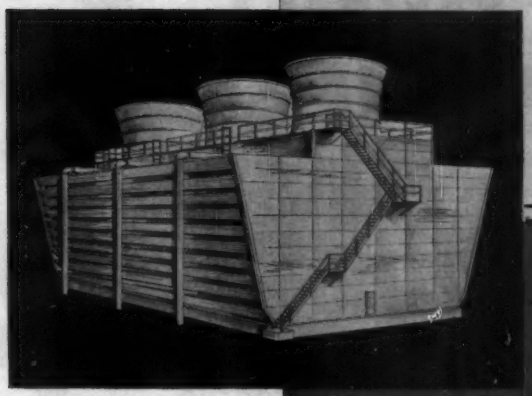
*New Class 600*

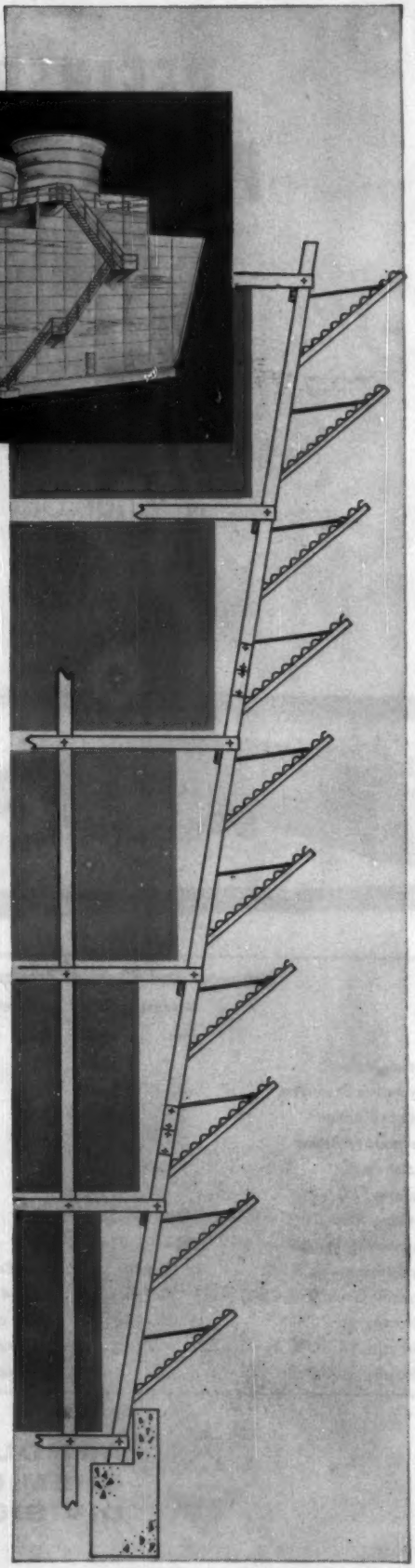
**MARLEY**

**Double-Flow**

*has the*

# Profile with a Purpose





Comprised of a combination of "active" angles, the contour of Class 600 cooling towers is completely functional with positive influence on performance and operation. Each angle has its specific purpose and, in conjunction with the others, creates additional advantages.

**Louver Angle:** The 42-inch louvers are positioned on 3-foot centers at an angle of 40° from horizontal. This arrangement readily admits more air to do more cooling—with inherent lowering of static drop, higher working velocities in the fill become completely practical. It increases the atmospheric performance potential (always greatest in cross-flow towers) and it eliminates splash-out.

**Structural Angle:** The 10° angle outlined by the louver posts is of equal importance. It makes possible uniform fill width or uniform *air travel* at all levels in the cooling chamber. Result: more performance per cubic foot of structure gained through efficient air utilization.

**Fill Angle:** With a uniform fill-to-louver distance maintained at every fill story, Class 600 Double-Flows set up an effective barrier against icing. The normal *water travel* creates a continuous curtain of water between fill and louvers without splash-out. There are no non-functional voids so the heat of the water prevents formation of sheet ice and blocking of air entrance.

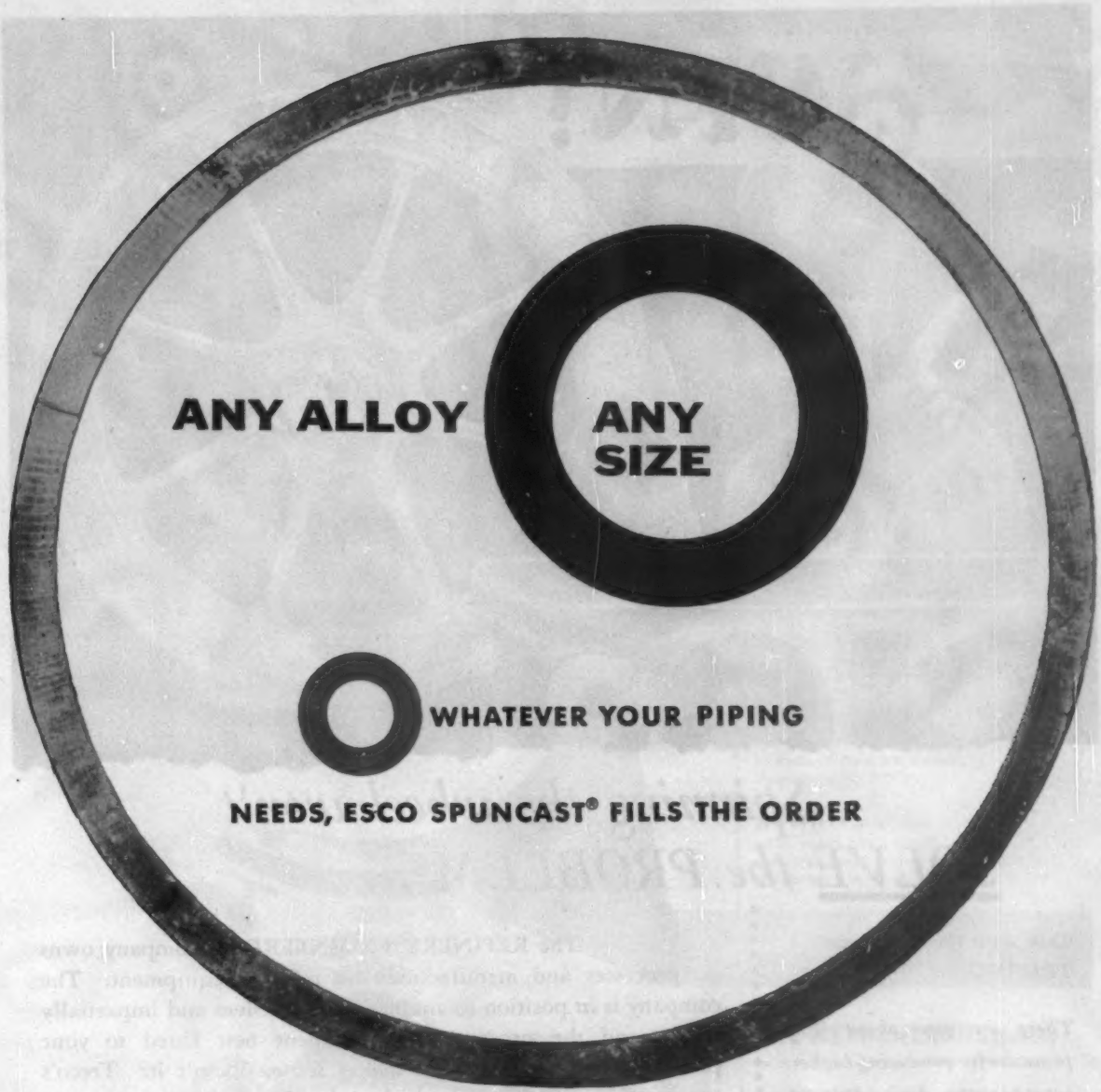
MARLEY

**The Marley Company**

Kansas City, Missouri



For more data on advertised products, use Readers' Service Cards, last page.




Corrosion, heat, abrasion or vibration, you can reduce them all with *ESCO* Spuncast pipe. Centrifugally cast in a wide variety of *ESCO* alloy steels, heat treated and tested, *ESCO* Spuncast pipe will cut replacement costs in chemical, pulp and paper and petro-chemical plants, or in any other type of installation subject to severe conditions.

Available in special alloys, in sizes to 36" OD and wall thickness from ¼" up and in large or small quantities *ESCO* Spuncast Pipe is the greatest corrosion-resistant value your pipe dollars can buy.

**Write for free booklet—"How to Cut Costs With *ESCO* Spuncast"**

**ESCO**

**ELECTRIC STEEL FOUNDRY COMPANY**

2164 N. W. 25TH AVE. • PORTLAND 10, OREGON
MFG. PLANTS AT PORTLAND, ORE. AND DANVILLE, ILL.
Offices in Most Principal Cities
ESCO INTERNATIONAL, NEW YORK, N. Y.
IN CANADA ESCO LIMITED



For more data on advertised products, use Readers' Service Cards, last page.

# *Spinning the wheel won't SOLVE the PROBLEM . . .*

*Talk with the Man from TRECO . . .*

*There are now about fifty processes for producing higher octane motor fuels. One of them is best for you; but which one? Spinning a wheel won't locate it. Why not have a talk with a Treco representative?*

The REFINERY ENGINEERING Company owns no processes and manufactures no refinery equipment. The company is in position to analyze your problem and impartially recommend the process and equipment best fitted to your product requirements. That makes sense, doesn't it? Treco's construction experience, backed up by the staff's experience in actual refinery operation, assures you of getting most for your money.

Treco, with an outstanding record of fast refinery completion, will have your plant "on stream" in a hurry, thus producing more savings for your company.

....talk with the TRECO man.....

TRECO

A DIVISION of VITRO CORPORATION of AMERICA

**The REFINERY ENGINEERING Company**

NEW YORK TULSA TORONTO

# for these recent oil refinery projects

# CAPOSITE insulation was supplied

**BAHRAIN** *at Awali*
for Bahrain Petroleum Co. Ltd.
Main Contractor: Foster Wheeler Ltd.

**BURMA** *at Syriam*
for The Burma Oil Co. (1954) Ltd.
Main Contractor: Foster Wheeler Ltd. (London)

**CANADA** *at Clarkson, Ontario*
for British American Oil Co. Ltd.
Main Contractor: The Lummus Co.

**COLOMBIA** *at Cartagena*
for International Petroleum Co. Ltd.
Main Contractor: Bechtel Corporation
(Insulation Contractor: Harold Aber & Co.)

**ECUADOR** *at La Libertad*
for the Anglo-Ecuadorian Oil Co. Ltd.
Main Contractor: Procon (G.B.) Ltd.

**ENGLAND** *at Kent Oil Refinery*
for The British Petroleum Co. Ltd.

**FRANCE** *at Raffinerie de Normandie*
for Compagnie Francais de Raffinage.
Main Contractors: Kellogg International Corporation and Foster Wheeler Ltd. (France).
(Insulation Contractor: Soc: Technisol).

**IRAQ** *at Daura, near Baghdad*
for Iraq Government Oil Refinery Administration.
Main Contractor: Foster Wheeler Ltd. (London).

**ITALY** *at Genoa*
for Raffineria Dottore E. Garrone.
Main Contractor: C.T.I.P.

**KUWAIT** *at Akmadi*
for the Kuwait Oil Co. Ltd.
Main Contractors: Bechtel-Wimpey and E. B. Badger & Sons Ltd.

**THE NETHERLANDS** *at Pernis*
for N. V. de Bataafsche Petroleum Maatschappij.

**NETHERLANDS ANTILLES**
*at C.P.I.M. Refinery, Curacao*
for Royal Dutch-Shell Group.

**SCOTLAND** *at Grangemouth*
for British Hydrocarbon Chemical Co. Ltd.
Main Contractor: E. B. Badger & Sons Ltd.

**VENEZUELA** *at Maracaibo*
for The Richmond Exploration Co.
Main Contractor: The Lummus Co.

**CAPOSITE** reg'd.
**Amosite Asbestos Blocks and Pipe Sections**

Speedy application .... long-lasting protection .... resilience to withstand rough handling .... long fibred Amosite asbestos, giving superior insulating properties — these are the reasons why CAPOSITE is being specified for more and more of today's refineries.

**CAPOSITE** *is also manufactured in* SOUTH AFRICA, ITALY, CANADA, FRANCE, HOLLAND, SPAIN

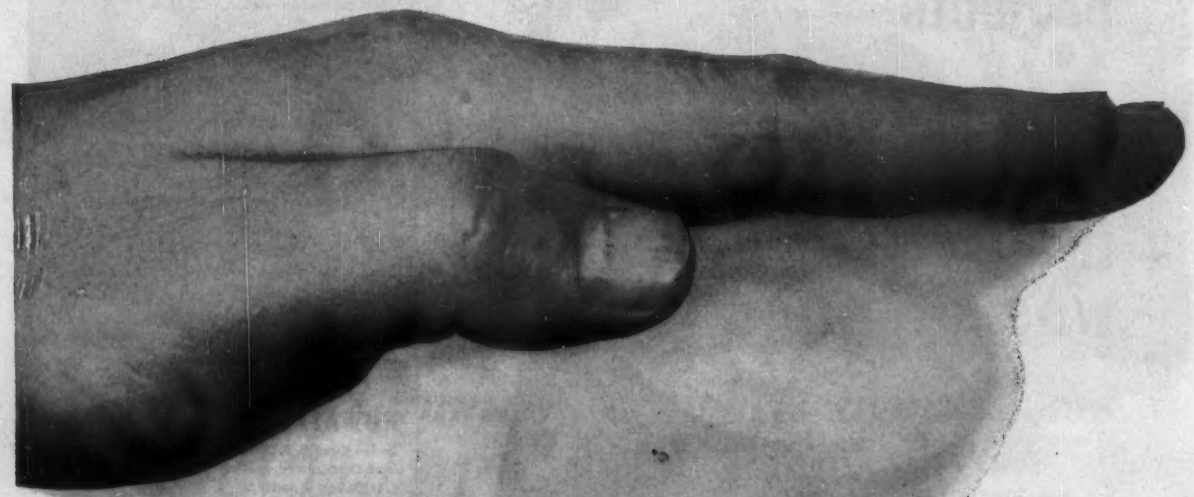
**THE CAPE ASBESTOS COMPANY LTD**
114 & 116 PARK STREET, LONDON, W.1
Tel: GROsvenor 6022 Cables: Incorrupt London

Enquiries in Canada to:
Cape Asbestos (Canada) Ltd., 200 Bloor Street East, Toronto, Ont.
U.S.A. to: North American Asbestos Corpn., Board of Trade Building, Chicago, 4, Illinois

TA 415

*new* **S&J** *Breather Valves*

# Materially Reduce Storage Tank Vapor Loss



New Shand and Jurs model ST-9749 diaphragm-type breather valves are a major achievement in storage tank venting and vapor conservation. They provide resistance to sticking, corrosion and freezing never before offered. In addition they require practically no maintenance feature non-wetting teflon-on-fiberglas diaphragms for maximum performance and longer life; completely eliminate critical drain holes or other areas that require continuous checking. Ruggedly built from aluminum and stainless steel, ST-9749 breather valves are lightweight, and already available in 4″, 6″, 8″, and 10″ sizes. Call your nearest S&J branch office or sales representative for Technical Bulletin 52D-ST-9749 Breather Valve.

**SHAND AND JURS**

GENERAL PRECISION EQUIPMENT CORPORATION GPE

2600 Eighth Street, Berkeley, California
Branch offices and representatives in principal cities

# ALUMINUM GATE VALVES

## BY DARLING

***FEATURING:***

**unmatched advantages of DARLING fully revolving double disc parallel seat gate valve principle!**

There's new economy to be gained in the handling of "problem" fluids and gases with Darling aluminum alloy gate valves . . . now available in ½" through 24" sizes. We have data on initial and long-range costs and performance that will interest you. Write for facts.

**DARLING VALVE & MANUFACTURING CO.**

Williamsport 31, Pa.



For more data on advertised products, use Readers' Service Cards, last page.

# Fractionator Towers . . . By the Three Carload

When it comes to making big towers, Graver has fabricated many in its 100 years association with the petroleum and chemical industries.

One of the latest is shown here—all 90 tons of it. This is a fractionator for refinery feed stocks. Formed of A285-C firebox quality steel for pressures up to 220 psig and temperatures to 650°, the tower is 107′ 5″ overall by 7′, 9′, and 11′ diameters. Radio-graphed and then stress-relieved in Graver's big heat-treating furnace, the finished tower is another proof of Graver's skills in fabricating large processing equipment.

Graver's nationwide plants are strategically located to render eminently satisfactory service on all types of processing equipment, pressure vessels and conservation tankage. As one of America's most experienced custom fabricators of such equipment—in both steels and alloys, Graver's versatile skills and modern techniques can always be depended upon to produce the quality fabrication you require.

GRAVER

*Building for the Future on a Century of Craftsmanship in Steels and Alloys*

GRAVER TANK & MFG. CO., INC.

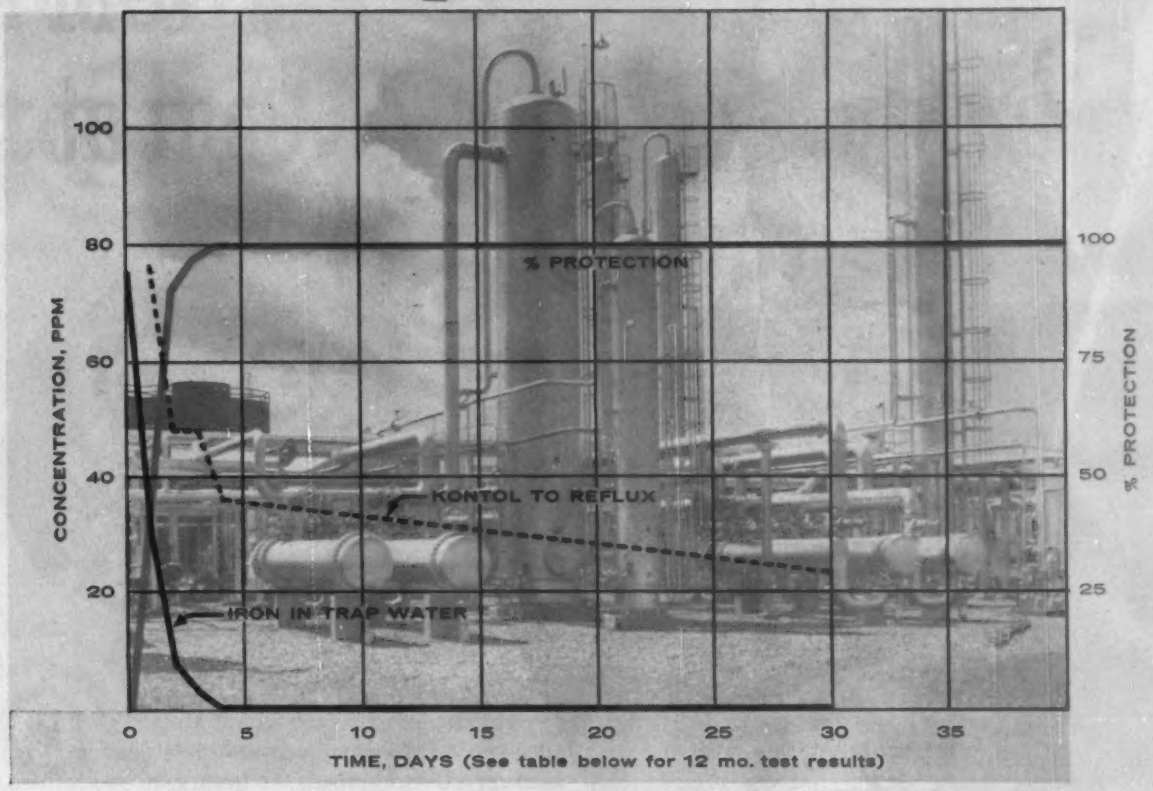
EAST CHICAGO, INDIANA • New York • Philadelphia
Edge Moor, Delaware • Pittsburgh • Atlanta • Detroit • Chicago
Tulsa • Sand Springs, Oklahoma • Houston • New Orleans
Los Angeles • Fontana, California • San Francisco



For more data on advertised products, use Readers' Service Cards, last page.

report on a mid-continent gasoline plant...

# KONTOL reduces absorber corrosion from 75 to 0 ppm iron in just 4 days!




Severe corrosion of the trays and walls of the stills were noted in a mid-continent gasoline plant's absorber. The still was fed with 432,000 gpd absorber oil and 130,000 gpd gasoline reflux. Iron contents of water taken from the tray traps prior to treatment were found to average 75 ppm and the water had a rich red color due to iron oxide products.

KONTOL was injected in the gasoline reflux line by a high pressure proportioning pump. Following is the corrosion survey record for the still:

| Test Period (Days) | Iron (PPM) | KONTOL Injected/Day (Gals) | KONTOL to Reflux (PPM) |
|---|---|---|---|
| Prior to treatment | 75 | None | — |
| 1 | 30 | 11.5 | 77 |
| 1 | 7 | 7 | 46 |
| 1 | 3 | 7 | 46 |
| 14 | 0 | 4.8 | 32 |
| 30 | 0 | 3.5 | 23 |
| 30 | 0 | 1.6 | 10 |
| 30 | 0 | 1.9 | 12 |
| 30 | 0 | .9 | 6 |
| 60 | 0 | .9 | 6 |
| 30 | 0 | 1.2 | 9 |
| 30 | 0 | .8 | 7 |
| 30 | 0 | 1.0 | 7 |
| 30 | 0 | .8 | 6 |

**FREE BULLETIN**
describes KONTOL more fully.
Yours on request.

# TRETOLITE COMPANY

DIVISIONS OF PETROLITE CORPORATION

369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

*Chemicals and Services for the Petroleum Industry*

DESALTING • CORROSION INHIBITING • DEMULSIFICATION • SCALE PREVENTION • WATER DE-OILING • METAL DEACTIVATION • ADDITIVES

***ASK THE MAN IN THE TRETOLITE CAR***
*He'll show you how to get maximum results at minimum cost from your KONTOL treatments.*

KG-58-1



For more data on advertised products, use Readers' Service Cards, last page.

# In developing THERMOBESTOS Insulation

# J-M at

**Not damaged by water.** Thermobestos has the moisture resistance outdoor service demands. Soak it in water for one day or 365—and you can still walk on it without damage. Dry it out and Thermobestos is as good as new, with conductivity and structural strength unimpaired.

**Low Conductivity.** The low thermal conductivity of Thermobestos is best demonstrated in actual service where it makes possible accurate, uniform temperature control, helps reduce fuel costs and contributes materially to operating efficiency.

**Johns-Manville**



For more data on advertised products, use Readers' Service Cards, last page.

for outdoor process industry applications

# research scientists didn't stop top insulating effectiveness...

*They added the three physical properties you most wanted—*
*HIGH STRENGTH—LIGHT WEIGHT*
*—MOISTURE RESISTANCE!*

Thermobestos® offers the lowest k factor of all insulations in general use throughout the process industries. For maximum heat control on outdoor piping and equipment operating at temperatures to 1200F it just can't be beat!

Yet top insulating effectiveness is only one reason why more and more engineers are specifying Thermobestos for refineries, chemical plants, and wherever hot outdoor vessels and piping must be insulated. For Thermobestos also offers a threefold bonus . . .

**. . . Three outstanding physical properties**

Thermobestos is 1) strong and rigid. Its hard composition resists crushing and easily withstands unusual service abuse. Yet it is 2) lightweight for easy handling and fast application. And it is 3) highly moisture resistant, remains undamaged even by prolonged wetting.

**Quickly, easily applied**

Thermobestos is made from hydrous calcium silicate . . . molded to size for proper fit. Its high strength makes it particularly adaptable for time-saving shop prefabrication of fittings and bends.

Furnished in large sections, Thermobestos is easy to apply. It reduces the number of joints. In pipe insulation form, it comes in a complete selection of sizes up to 30″ O. D. Also available in 6″ x 36″ and 12″ x 36″ blocks in a full range of thicknesses.

For further information write for your free copy of the 12-page Thermobestos booklet, IN-169A. Address Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

**INSULATIONS** FOR LASTING THERMAL EFFICIENCY
MATERIALS · ENGINEERING · APPLICATION

JOHNS-MANVILLE JM PRODUCTS



For more data on advertised products, use Readers' Service Cards, last page.

**HARSHAW**

**has the facilities for producing carload quantities of**

**PREFORMED CATALYSTS**

**to fit special process requirements**

| | |
|---|---|
| Hydroforming | Dehydration |
| Cyclization | Desulphurization |
| Oxidation | Alkylation |
| Dehydrogenation | Isomerization |

Hydrogenation

## CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

Aluminum Nitrate — Cobalt Nitrate
Copper Nitrate — Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)
Nickel Carbonate — Nickel Formate — Nickel Nitrate
Nickel Sulfate — Sodium Methoxide — Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

***Write for FREE Booklet, "HARSHAW CATALYSTS"***

HARSHAW

**THE HARSHAW CHEMICAL CO.**

**1945 EAST 97th STREET • CLEVELAND 6, OHIO**

**Chicago • Cincinnati • Cleveland • Hastings-On-Hudson, N.Y. • Houston • Los Angeles**
**Detroit • Philadelphia • Pittsburgh**



**For more data on advertised products, use Readers' Service Cards, last page.**

Exchangers like these serve dependably throughout the industry.

**We are proud to serve the**

# PETRO-CHEMICAL INDUSTRY

**in Custom-Design, Fabrication and Repair of**

# HEAT EXCHANGERS

Qualified for Construction in Ferrous and Non-Ferrous Materials

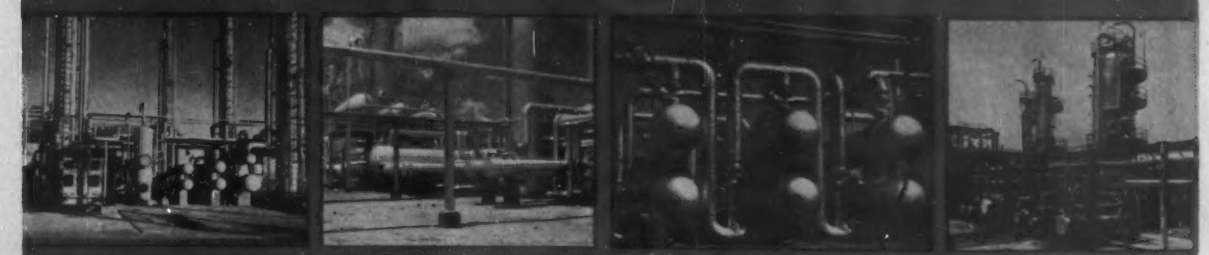
MTF

API-ASME and ASME Code Construction

*Your inquiries are cordially invited.*

## TEXAS METAL FABRICATING COMPANY

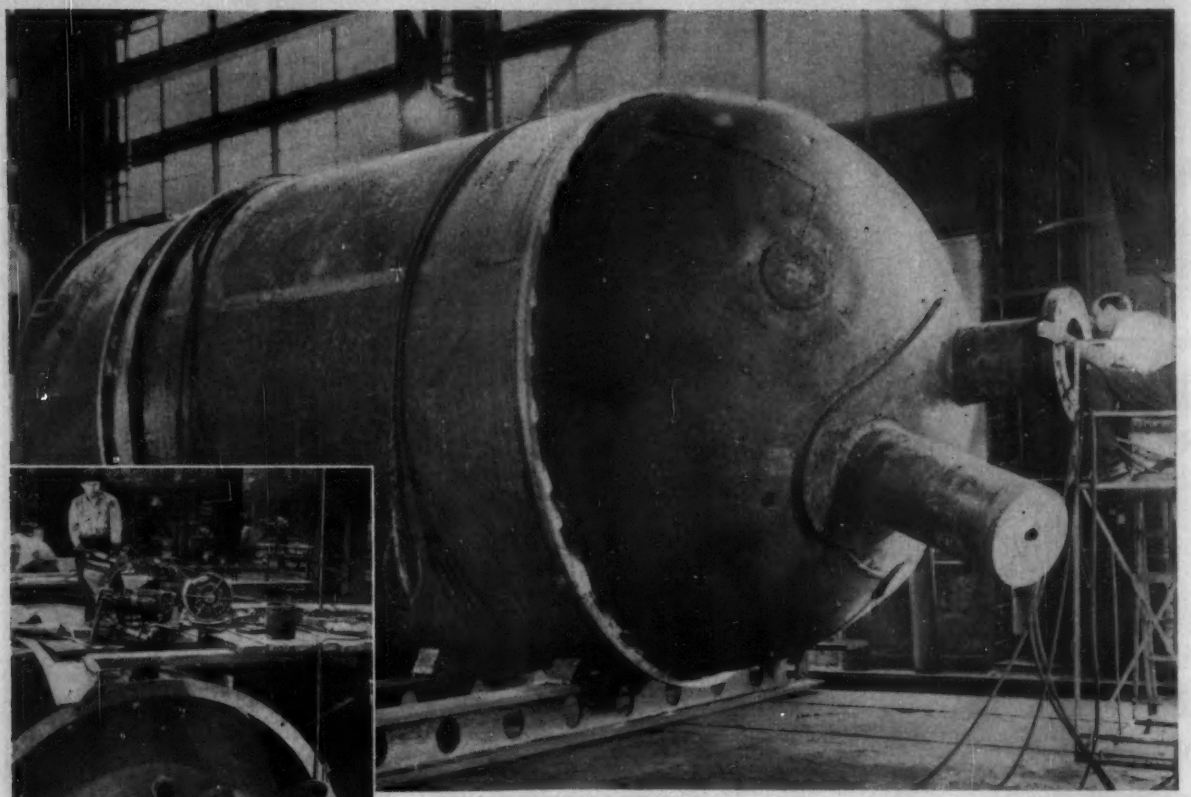
P. O. Box 7567, Houston 7, Texas



Major petro-chemical plants rely on superior equipment.

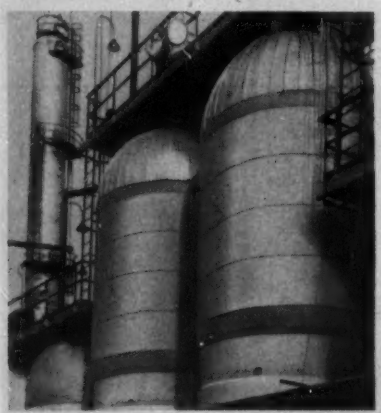
For more data on advertised products, use Readers' Service Cards, last page.

# 20 ft. long, 12 ft. in diameter, 13 kinds of steel . . . typical of the tough pressure vessel welding jobs Baldwin is noted for



Built by B-L-H's Eddystone Division, a 100-ton pressure vessel made chiefly of chrome molybdenum steel is here shown being inspected by an Eddystone engineer.

Automatic submerged metal arc was one of three welding methods employed on this huge pressure vessel.



Identical vessels fabricated by B-L-H and installed in the catalytic reforming unit of an ultramodern refinery.

A major oil company recently called on Baldwin-Lima-Hamilton's Eddystone Division to weld two identical 100-ton pressure vessels that must operate continuously for long periods of time at nearly 1000°F in a hydrogen-rich atmosphere at pressures up to 536 psi. Baldwin successfully met the challenge of this big job.

Thirteen different kinds of steel ⅜ in. to 5⅛ in. thick and three welding methods—manual-shielded metal arc, automatic submerged metal arc, and inert gas—had to be used on the vessels, each 20 ft. long, 12 ft. in diameter. As on all Baldwin work, only qualified welders were used.

Radiographic inspection of all welds revealed no defects. After the vessels were hydrostatically tested at 1575 psi for 3 hours, all seams were examined for leaks and found to be tight.

For a copy of our illustrated Weldment Bulletin 7001 or for specific information on how we may be of service to you, write to B-L-H Corporation, Philadelphia 42, Pa.

**BALDWIN · LIMA · HAMILTON**

Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools

Struthers Wells

# FIRED HEATERS

## DIRECT OR INDIRECT HIGH TEMPERATURE HEATING for the PETROLEUM AND CHEMICAL INDUSTRIES

**DIRECT HEATING**
of hydrocarbon oils, gases, for gas cracking, steam superheating and many other services.

**INDIRECT HEATING**
using Dowtherm, Aroclor, heat transfer oil, liquid metals and other heat transfer mediums.

**SPECIAL HIGH TEMPERATURE EQUIPMENT DESIGNED TO YOUR REQUIREMENTS**

The photos show two tar separator heaters installed at a new refinery in Mississippi. These heaters are provided with alloy tubes, capacity 54,000,000 BTU per hour each. A total of seven Struthers Wells fired heaters were installed in this plant.

Struthers Wells supplies high-temperature heating equipment for a wide variety of services and industries. Temperatures range to above 1650°F. Struthers Wells heaters are characterized by trouble-free operation, long life and high thermal efficiencies. Hundreds of installations throughout the U.S. and some 15 foreign countries indicate the universal acceptance of Struthers Wells fired heaters.

## STRUTHERS WELLS CORPORATION

WARREN, PA.

Struthers Wells

*Offices in Principal Cities*

*Plants at Warren, Pa. and Titusville, Pa.*

**CHEMICAL PROCESSING DIVISION**
Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

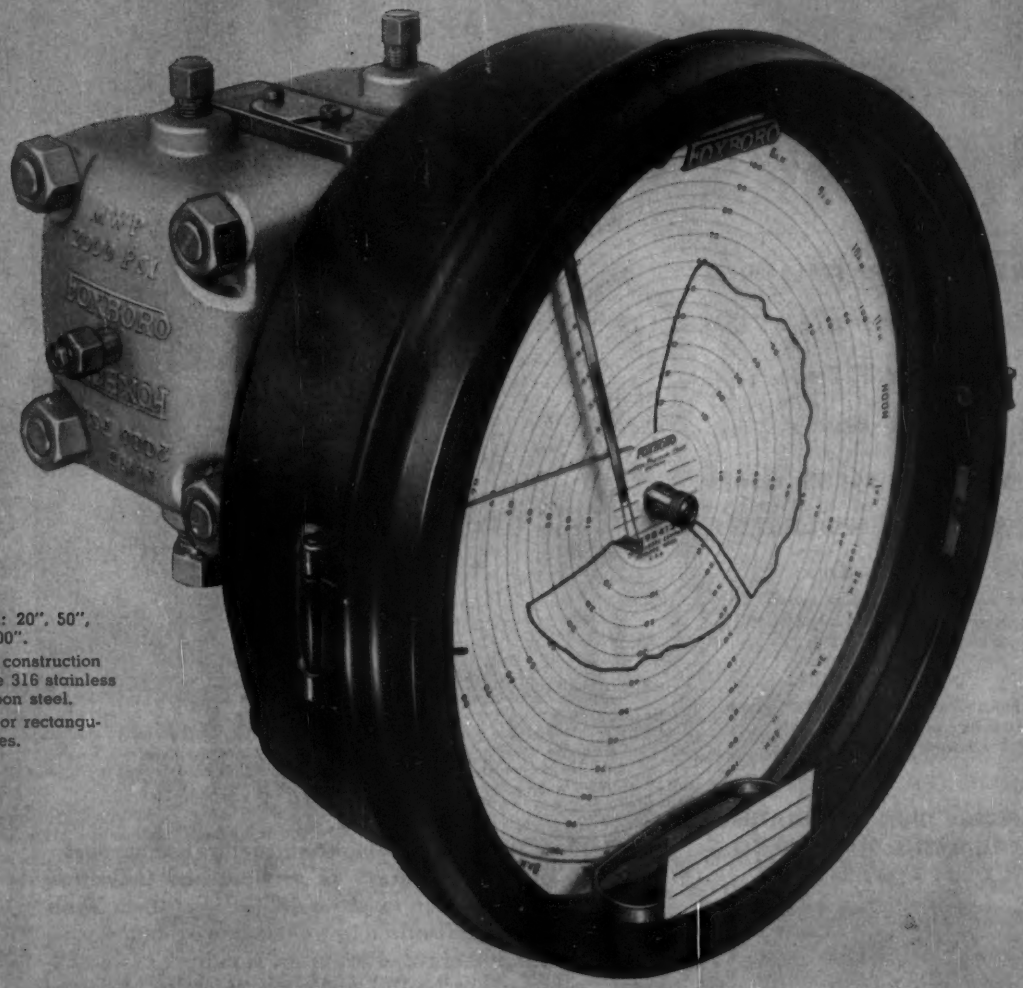
**BOILER DIVISION**
BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

**FORGE DIVISION**
Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening & Back-up Rolls



For more data on advertised products, use Readers' Service Cards, last page.

# NOW... a "Dry" Flow Meter with..

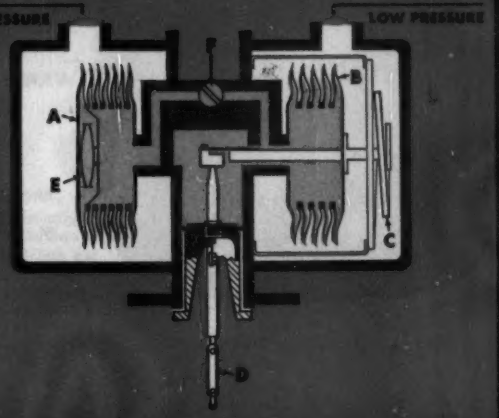



- Ranges: 20", 50", 100", 200".
- Forged construction in Type 316 stainless or carbon steel.
- Round or rectangular cases.

## ...the new Foxboro Type 37 Diaphragm Meter

### How It Works

In schematic drawing at right, areas shown in color represent a stable, non-freezing liquid. Any pressure increase in the high pressure chamber compresses Diaphragm Unit A, displacing its liquid and expanding Diaphragm Unit B until force of Range Spring C equals the difference between the forces on Diaphragm Units A and B. Linear motion of Diaphragm Unit B moves inner end of Drive Bar D — outer end moves correspondingly through the bellows-sealed flexure bar, driving pen arm. Built-in Temperature Compensator (E) proportionately adjusts diaphragm capacity as ambient temperature variations affect volume of filling fluid. External damping adjustment is shown at F.



# •complete overrange protection!

# •sustained high accuracy!

Now you can have mercuryless flow measurement for a wide range of differential pressures — at static pressures up to 2000 psi — with greater safety and dependability than ever before!

The new Foxboro Type 37 Diaphragm Meter not only combines unmatched ruggedness and precision in a dry meter — it's by far the easiest to adjust and maintain. And it does away with zero drift problems, once and for all!

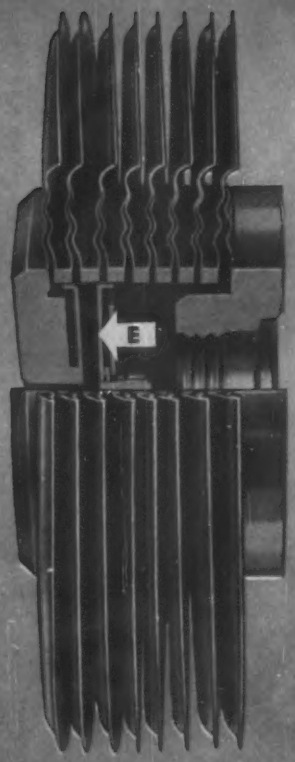
Expansible, Type 316 S.S. diaphragm elements respond to changes in pressure with unmatched sensitivity, yet are completely immune to overrange up to full static pressure! A unique packless drive bar precisely transmits linear motion to the pen arm. Range-changing is easy, due to new twin-spiral spring design. Wide range damping is externally adjustable under pressure. And the Type 37 is self-compensating for temperature changes in all differential ranges.

Get full details on this high utility, completely dependable dry flow meter. Arrange for a demonstration with your nearby Foxboro Field Engineer, or write **The Foxboro Company, 744 Neponset Ave., Foxboro, Mass., U.S.A.**

**FOXBORO**

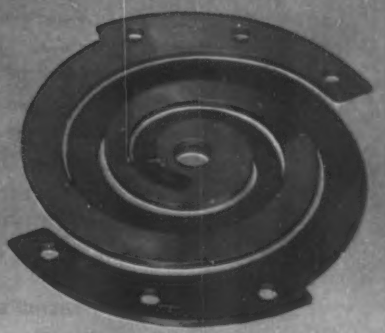
REG. U.S. PAT. OFF.

**FIRST IN FLOW METERING**



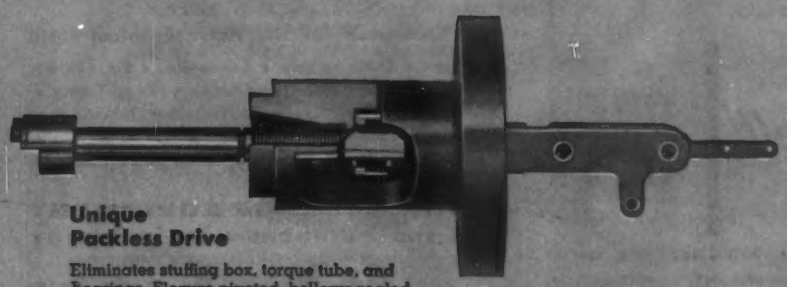

**Exclusive Diaphragm Elements**

Type 316 S.S. diaphragm units in both high and low pressure chambers provide greatest linearity and freedom from hysteresis; nesting design and integral spacer rings provide safe, positive, overrange protection. Temperature compensation (E) is built into diaphragm assembly . . . never requires change or adjustment.



**Exclusive Range Springs**

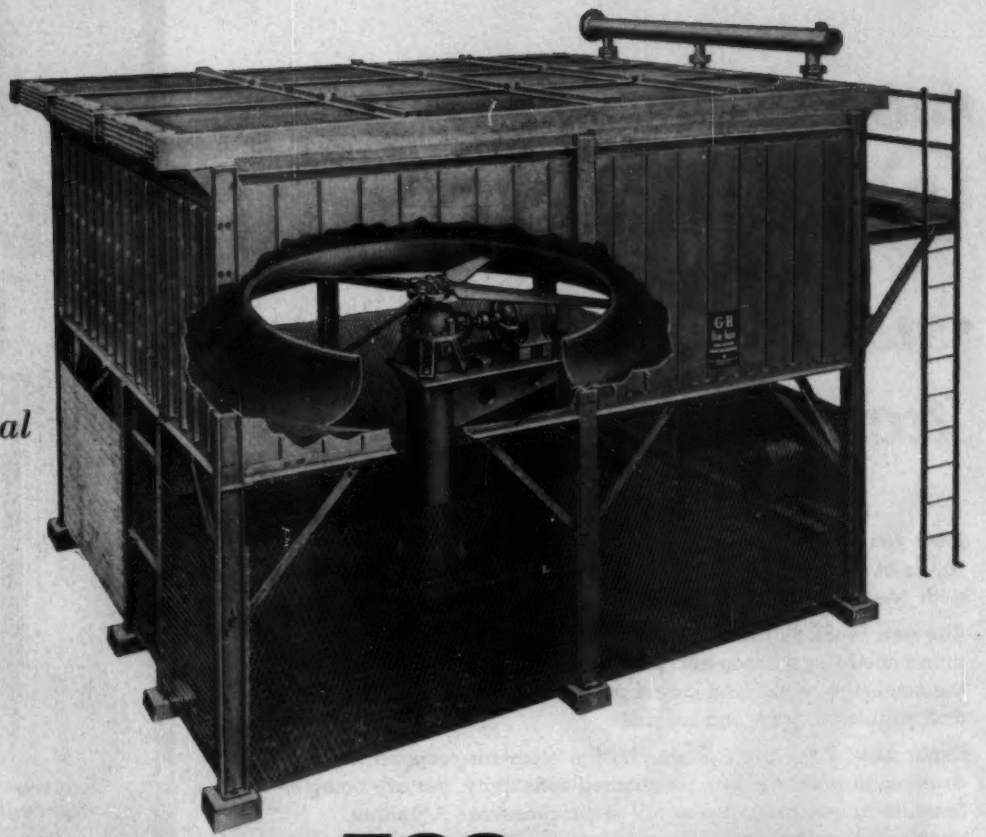
Heavy gauge Ni-Span C alloy, twin-spiral springs provide high sensitivity with lasting accuracy. Readily accessible . . . range changes are easily made, in minutes!



**Unique Packless Drive**

Eliminates stuffing box, torque tube, and bearings. Flexure-pivoted, bellows-sealed drive bar transmits diaphragm's linear motion to the pen arm with unequalled sensitivity *and undiminished* power. Seal for flexure pivot is a tough, flexible bellows.

*Designed for the Petrochemical Industry*



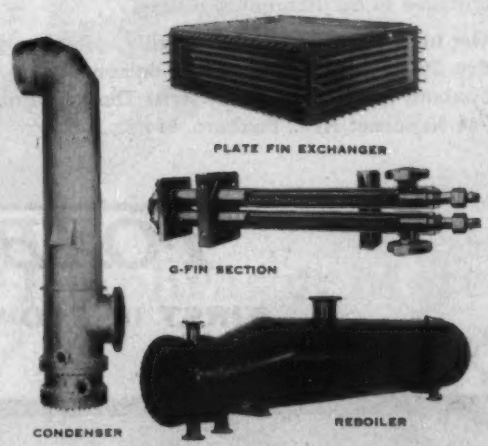
# Proved in over 500 installations

**Griscom-Russell fin-fans,** by eliminating the cost of water, pumps, piping, valves, water treatment and maintenance, are the economical heat exchangers for many petrochemical cooling and condensing services.

G-R **fin-fans** are designed of the highest quality components to fit your special application. The transfer area is made of G-R's strong, helically finned tubing for highest efficiencies. Exceptional design and pre-fabricated construction minimize installation and maintenance expenses.

**fin-fans** are available in forced or induced draft designs with a wide range of capacities. Many accessories are available to solve special drive, control and weather problems.

**Send for Griscom-Russell Bulletin 2400.**




**G-R Designed for the Petrochemical Field**

Reboilers • G-Fin Sections • Condensers • Plate Fin Exchangers • Longitudinally and Helically Finned Tubing • Bentube Evaporators • Liquid Heaters • Tubular Heat Exchangers • Solution Heaters • Oil and Water Coolers • Tank Heaters • Gas Coolers • Bentube Sections

**HEAT EXCHANGE EQUIPMENT FOR THE PETROCHEMICAL INDUSTRY**

GR 390

Griscom-Russell

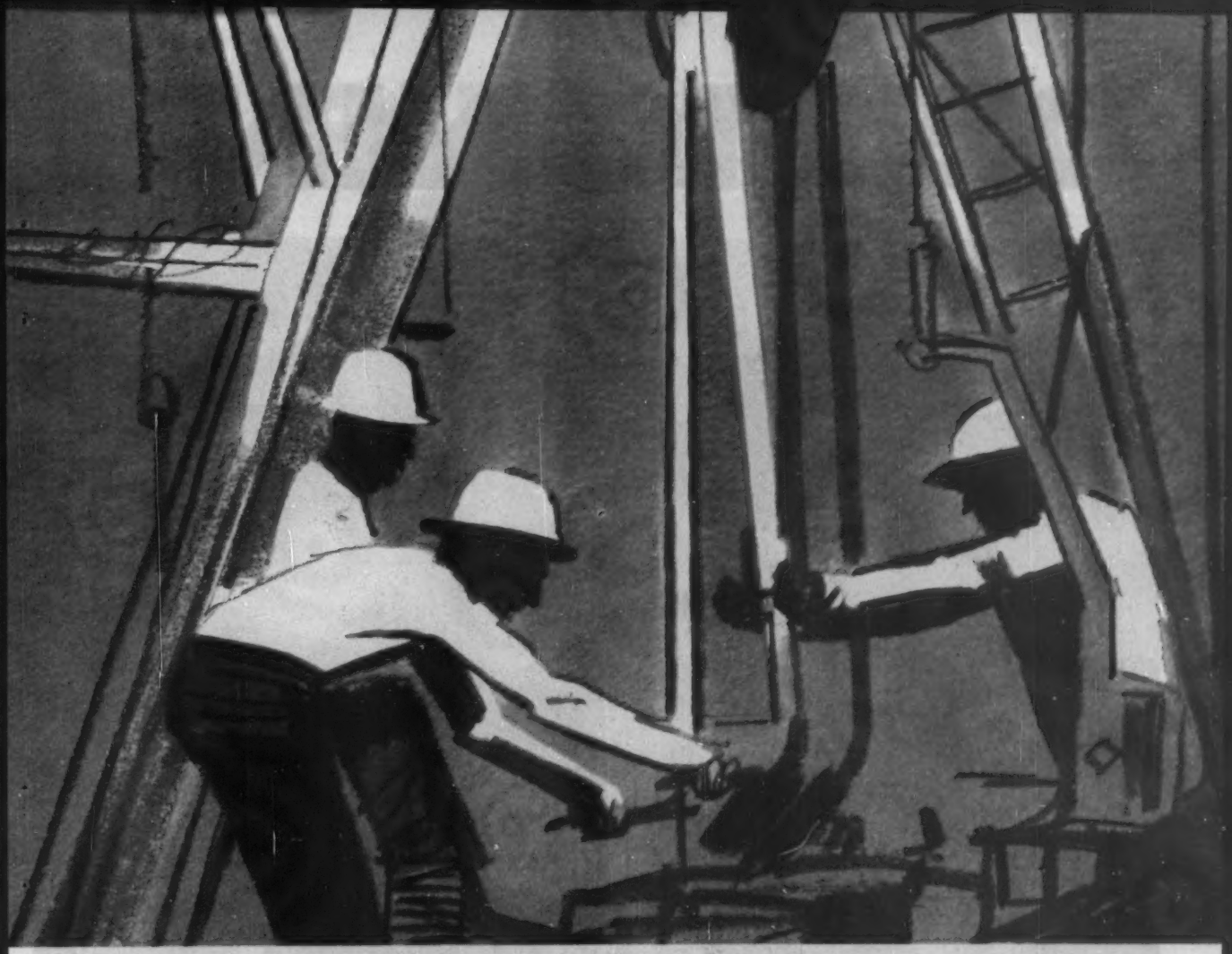
GENERAL PRECISION EQUIPMENT CORPORATION

**THE GRISCOM-RUSSELL COMPANY • MASSILLON, OHIO**

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION



For more data on advertised products, use Readers' Service Cards, last page.



# Sign of Water.... Layne

Vital to most petroleum operations is a guaranteed supply of water. Water for removing heat loads, process consumption and accompanying plant operations—all require determined amounts for an hour, a day, a year—indefinitely. That's why the well site must be accurately determined and the well constructed to deliver the available water.

Layne wells circle the globe. Every condition and every problem possible has been met and solved. This know-how and over three quarters of a century of experience result in efficient, economical wells—the basis of many industrial water systems. Layne drilled wells provide a reliable water source—the criterion for industrial water supply.

**LAYNE & BOWLER, INC., MEMPHIS**
GENERAL OFFICES AND FACTORY • MEMPHIS 8, TENN.
LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

**WATER WELLS • VERTICAL TURBINE PUMPS**
**WATER TREATMENT**

TO: LAYNE & BOWLER, INC.
MEMPHIS 8, TENN.

*Gentlemen:* Please send me bulletin No. 100

*NAME*_____

*TITLE*_____

*ORGANIZATION*_____

*ADDRESS*_____

*CITY*_____ *STATE*_____

# DESIGNING

Photograph above shows status of 3,800 BPD cat reformer at the Denver refinery of Bay Petroleum Company (subsidiary of Tennessee Gas Transmission Company) just prior to completion. Designed to use Sinclair-Baker regenerative catalyst RD-150, this unit promises optimum yields of high octane reformate, low catalyst cost per barrel, and minimum equipment corrosion and contamination.

Kellogg has engineered and built cat reformers designed for catalyst RD-150 in capacities from 875 BPD to 24,000 BPD. Just before completion of the Bay unit, a 2,500 BPD reformer was placed on stream in Europe. A representative would be glad to discuss investment and operating costs, yields, catalyst life, and other pertinent details of Kellogg-designed cat reformers with interested oil refiners.

M KELLOGG W

# IN 3-D

## REDUCES INVESTMENT
## SPEEDS CONSTRUCTION

**Cuts Engineering Time**

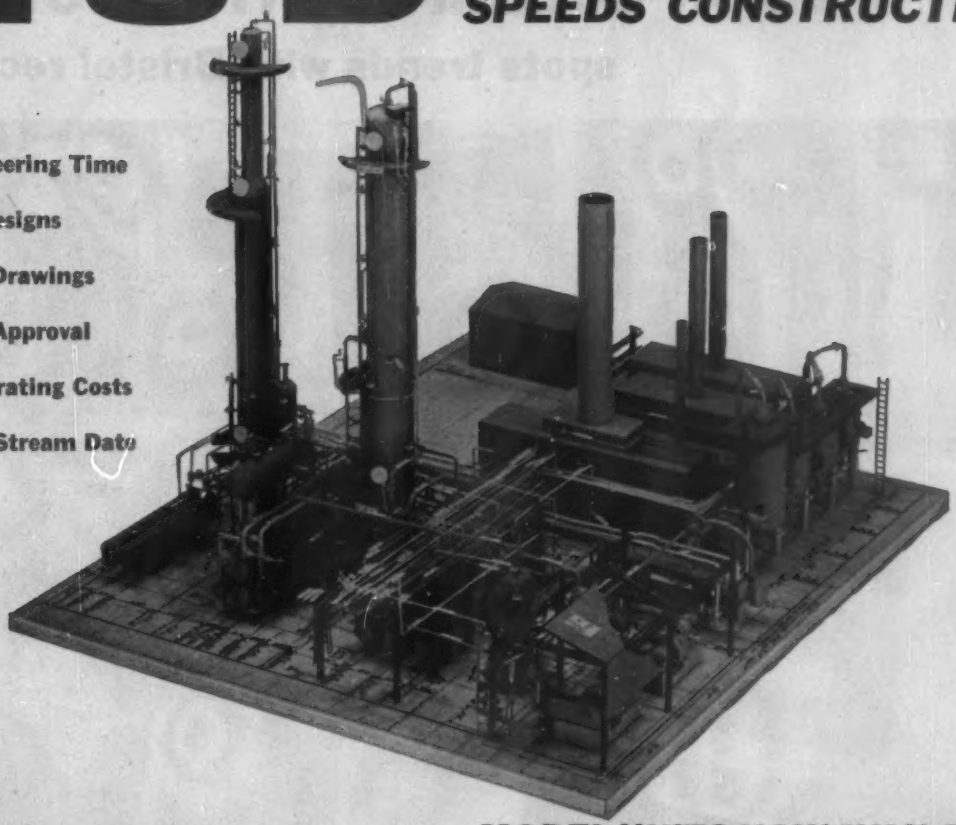
**Improves Designs**

**Minimizes Drawings**

**Facilitates Approval**

**Lowers Operating Costs**

**Speeds On-Stream Date**



A recent example of a Kellogg technique that is sweeping the industry, this cat reformer typifies the time-and-money-saving aspects of designing with scale models. These include: conventional drawings of over-all layout and piping eliminated; man-hours spent on piping design cut in half; engineering and construction completed in a fraction of the normal time. Kelloggram No. 5, sent on request, describes techniques and economics.

### MODEL UNITS NOW AVAILABLE

So that industry may benefit from the easily-assembled model units developed in conjunction with the technique, Kellogg is now making these plastic components available at low cost to industry and engineering schools. For information on how these components can be obtained, together with details on their use, write Kellogg's Contract Sales Division. Use coupon below.

**The M. W. Kellogg Company, 711 Third Avenue, New York 17, N.Y.**
A SUBSIDIARY OF PULLMAN INCORPORATED

☐ Send __ copies of 12pp Kelloggram No. 5, describing models and techniques.

☐ Send information on model components and how they may be obtained.

*Name*_____ *Title*_____

*Company*_____

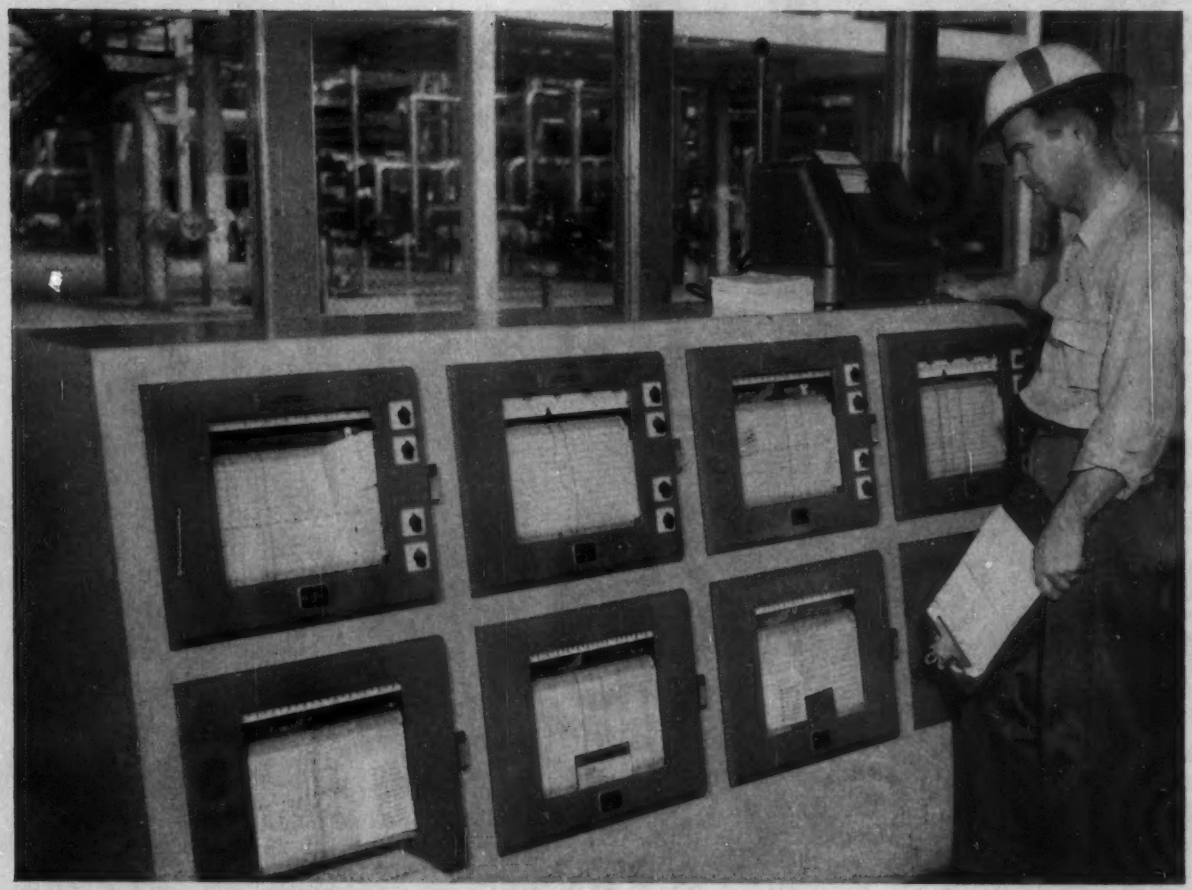
*Address*_____

*The Canadian Kellogg Company Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York*
*Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas*

PR 4/58

# "MILLION-DOLLAR" CONTROL SYSTEM

## spots trends with Bristol recorders



**THESE MULTIPLE-CHANNEL BRISTOL TREND RECORDERS**—one of several such groups—can spot troubles before they start at the Delaware Refinery of Tidewater Oil Company. All of the self-balancing bridge and potentiometer instruments in this modern plant are Bristol's. Instrument system designed and installed by Panellit Inc., Skokie, Illinois.

**Designed to nip trouble in the bud,** the "million-dollar" control system at the Delaware Refinery of Tidewater Oil Company features the latest analogue-to-digital scanning and logging techniques—and several batteries of patchboard-connected Bristol Dynamaster* trend recorders that can display almost any variable measured or controlled in the entire plant.

This uniquely flexible system lets the operator, in any of the plant's nine control rooms, record only those variables that need close, continuous checking. He simply plugs the recorders into the desired circuits at the patchboard and gets continuous records as needed.

Bristol Dynamaster electronic instruments are ideal as general-purpose recorders like these, and for special applications, too. The Dynamaster's high accuracy, outstanding flexibility, extremely broad range of accessory equipment, easy adaptability and exclusive features like No-Batt Continuous Standardization make it a consistent favorite among instrument men everywhere.

Find out how Bristol instruments—the most complete line of full-sized and miniature electronic and pneumatic instruments on the market—can help solve your difficult problems in recording, indication or automatic control. Write: The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

*T. M. Reg. U. S. Pat. Off.* 8.8

**BRISTOL** *TRAIL-BLAZERS IN PROCESS AUTOMATION*

**AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS**



For more data on advertised products, use Readers' Service Cards, last page.

*What's your tubing problem?*

# corrosion?
# damage?
# installation?
# fire? cost?

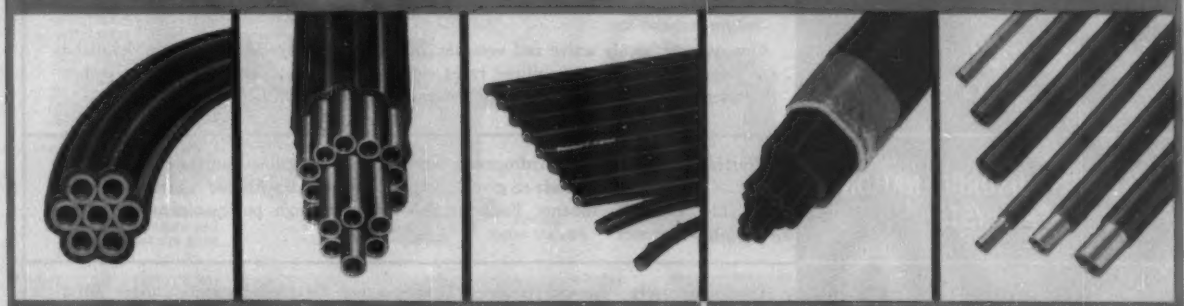
Wherever instrument tubing is used—be it refinery, natural gasoline plant, chemical, nuclear or food processing—Dekoron Tubing Products can help whip your ultimate twin problems of *maintenance-replacement expense and installation costs.*

Why?

First, because Dekoron Tubing products resist chemical attack and corrosion caused by moisture and industrial atmospheres. That means that once installed, Dekoron products are in to stay. You're not faced by perennial replacement and maintenance costs.

Second, the big savings in cost are yours in installation when you specify multiple-line Dekoron products—you install many instrument lines at once.

So if you have an instrument tubing problem of *any sort*, we probably have the answer *in stock*. If not, we can design and make it for you.



**POLY-COR**
From 2 up to 37 plastic tubes in plastic armor.

**METL-COR**
From 2 up to 19 copper or aluminum tubes in plastic armor.

**RIBBON**
M-Ribbon (metal) and P-Ribbon (plastic). 10 tubes in plastic sheath.

**PROTECTO-PAC**
Fire and impact resistant. Plastic tubes covered with plastic-asbestos-plastic armor.

**SINGLE-LINE**
Single steel, copper or aluminum tubes in plastic armor, or all-plastic tubing.

**Dekoron® products**
QUALITY • RESEARCH • SERVICE

**SAMUEL MOORE & CO.**
*Dekoron Products Division*
**MANTUA, OHIO**

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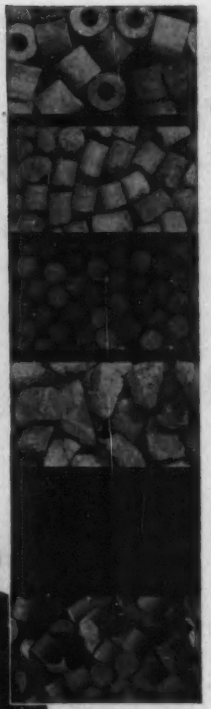
# HYDROGENATION CATALYSTS

## *How Girdler helps you solve hydrogenation problems*



• There are three important cost-cutting ingredients in Girdler catalyst service for hydrogenation applications:

**1.** Girdler's *proven hydrogenation catalysts*, such as listed, which are providing optimum operating economy in a wide variety of uses.

**2.** Girdler's accumulated *technical know-how* which is constantly finding new solutions to difficult hydrogenation problems.

**3.** Girdler's extensive catalyst *facilities* . . . manufacturing, research, development and technical service . . . which provide the ideal catalyst for *your* application.

Outline your catalyst problem and we will make specific recommendations. Bulletin GC 1256 describes the full line of Girdler catalysts . . . available on request.

| | |
|---|---|
| NICKEL CATALYSTS | Leaders in the generation and purification of synthesis gases, and for a wide variety of organic hydrogenations. Girdler's close control of reduction and careful selection of support materials impart unique properties for difficult process problems. |
| COPPER CHROMITE CATALYSTS | One of most highly active and versatile commercial hydrogenation catalysts. Available in regular and barium-stabilized types either as powder or especially strong pellets. Powder meets certain specific particle density requirements. |
| SELECTIVE HYDROGENATION CATALYSTS | Widely used to selectively hydrogenate acetylenic and diolefinic compounds in purification of olefins. Custom made to give optimum performance with due regard for process variables and contaminants. Facilitate production of high purity olefins for petrochemical processes. |
| COBALT MOLYBDENUM CATALYSTS | Used extensively by many refineries. Highly active. Developed specifically for sulfur conversion and for hydrogen treating to remove sulfur and nitrogen . . . also for upgrading a wide range of petroleum feed stocks. Excellent physical properties assure high operating economy and long life. |
| NOBLE METAL CATALYSTS | Pelletized forms of platinum and palladium catalysts for special applications. Advanced techniques produce highly active catalysts, economical both in manufacture and use. |

# GIRDLER CATALYSTS

CHEMICAL PRODUCTS DIVISION • NATIONAL CYLINDER GAS COMPANY

**Louisville 1, Kentucky**

GIRDLER MANUFACTURES CATALYSTS FOR: HYDROGENATION • SYNTHESIS GASES AND HYDROGEN GENERATION • DESULFURIZATION • NEW CATALYTIC PROCESSES

# PRECISION WORKMANSHIP
# DESIGN LEADERSHIP
# DEPENDABLE PERFORMANCE

YOU GET ALL THESE DESIRABLE FEATURES IN —

## R&S INDUSTRIAL CONTROLS for Hazardous Locations

Complete product lines for surface or panel mounting

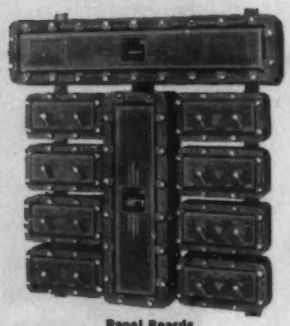
Many electrical equipment items today look quite similar, have standardized ratings and specifications . . . but there is one important difference — *QUALITY.*

By QUALITY we mean design leadership, dependable performance, and precision workmanship — three important features that make R & S electrical equipment for hazardous locations the standard of comparison.

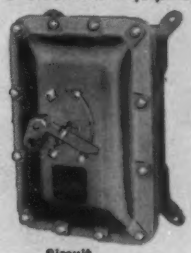
R & S electrical equipment is specified and preferred by architects, contractors, designers, engineers and maintenance men in all types of industries. Feature for feature, item for item, there is nothing finer for hazardous locations than the R & S complete line.

If you are concerned with the proper application of electrical equipment to eliminate dangers in your hazardous locations, let R & S help you solve any problem.

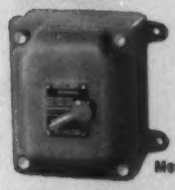
EFS Pilot Lights



Panel Boards Standard and Custom Built



Circuit Breakers



Manual Motor Starters

EFS Push Buttons and Selector Switches

Magnetic Motor Starters

EFS Switches

Combination Starters

### R & S Explosion-Proof, Vaportight, Waterproof and Weathertight STANDARD STOCK LINES

**EXPLOSION-PROOF EQUIPMENT**

- Explosion-Proof Lighting Fixtures
- Circuit Breakers
- Combination Starters
- Tumbler Switches
- Motor Starters
- Push Button and Pilot Light Stations
- Delayed Action Plugs and Receptacles
- Unialarm
- Monolarm
- Standard and Custom-Built Panelboards
- Disconnect Switches
- Sealing and Flexible Fittings
- Interlocked Switches and Combinations

**ELECTRICAL SPECIALTIES**

- SAF-T-ARC Plugs and Receptacles
- Floor Boxes
- Ever-Lok Plugs and Receptacles
- Vaportight Lighting Fixtures
- Dust-Tight Lighting Fixtures
- FS and FD Boxes, Receptacles and Switches
- Marine Switches, Receptacles and Fixtures
- Underwater Lighting
- Junction Boxes
- Angle Type Plugs and Receptacles

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**RUSSELL & STOLL COMPANY, INC. • 125 BARCLAY STREET, NEW YORK 7, N. Y.**

# RUSSELL & STOLL

***PRECISION-BUILT ELECTRICAL EQUIPMENT — SINCE 1902***




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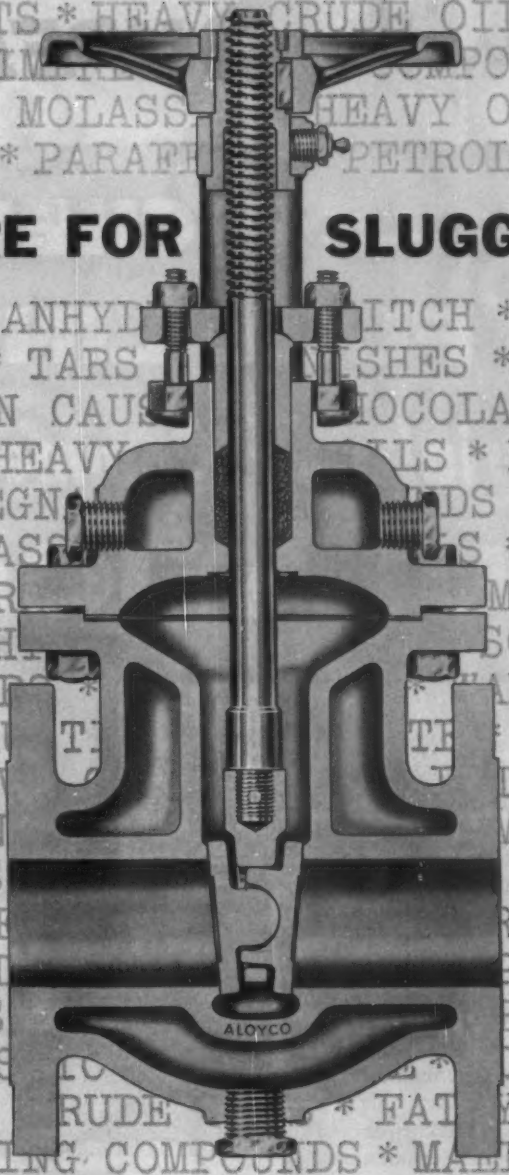
Harbison-Walker Refractories withstand Explorer's terrific blast-off heat!
The pad from which earth satellite Explorer was launched by the Army is paved with Harbison-Walker Extra Strength Castable Refractory.
HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
General Offices: Pittsburgh 22, Pa.
H-W
CASTABLE
HARBISON-WALKER REFRACTORIES CO.
The high refractoriness and great strength of Harbison-Walker Extra Strength Castable, which enable it to withstand blast-off temperatures and shock, make it particularly adapted for its wide industrial use.
Launching Pad paved with Harbison-Walker Castable Refractory

ASPHALT * MOLTEN CAUSTIC * CHOCOLATE * COAL TAR PRODUCTS * HEAVY CRUDE OILS * FATTY ACI DS * GUMS * IM COMPOUNDS * MAELIC ANHYDRIDE * MOLASS HEAVY OILS * HYDROGE NATED OILS * PARAF PETROLEUM RESIDUES

# SURE CURE FOR SLUGGISH FLUIDS

* PHTHALIC ANHYI ITCH * SOAPS * MOLT EN SULFUR * TARS ISHES * WAXES * ASPH ALT * MOLTEN CAUS OCOLATE * COAL TAR PRODUCTS * HEAVY ILS * FATTY ACIDS * GUMS * IMPREGN DS * MAELIC ANHY DRIDE * MOLAS S * HYDROGENATE D OILS * PAR M RESIDUES * P HTHALIC ANH SOAPS * MOLTEN SULFUR * TAR AXES * ASPHALT * MOLTEN CA COAL TAR PRO DUCTS * HEA TTY ACIDS * GU MS * IMPREGN MAELIC ANHYDR IDE * MOLAS HYDROGENATED OILS * PARA RESIDUES * PHT HALIC ANHYI PS * MOLTEN SU LFUR * TARS ES * ASPHALT * MOLTEN CAUS DAL TAR PRODU CTS * HEAVY RUDE * FAT Y ACIDS * GUMS * IMPREGNATING COMPOUNDS * MAELIC ANHYDRIDE




# COMPLETELY JACKETED ALOYCO VALVES

Aloyco Jacketed Valves are the surest way to keep slow moving corrosives flowing because they maintain higher temperatures than valves heated by other methods.

Jacketed valves are made in a variety of sizes and pressures and are furnished with convenient inlet and outlet holes for heating with steam or other media. They are available in 18 8S, 18 8SMO, Aloyco 20 and other analyses to specification.

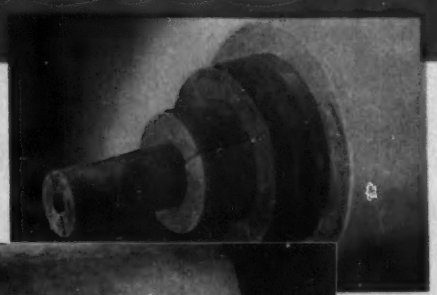
The broad Aloyco Valve line includes Jacketed Gate (above) Globe and Check Valves, the first Jacketed Valves ever integrally cast in high alloys. One more indication of Aloyco's leadership in pattern making, foundry techniques and engineering skills. Long experience in these areas has made Aloyco the world's foremost specialist in Stainless Steel Valves.

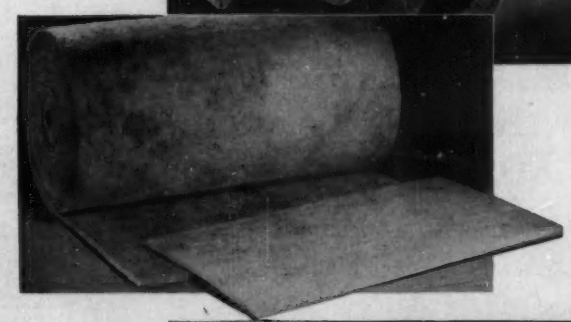
Ask Aloyco's Corrosion Engineering Service to work with you on your valve problems. Alloy Steel Products Company, 1303 West Elizabeth Avenue, Linden, New Jersey. 7.12

**ALLOY STEEL PRODUCTS COMPANY**

# NOW with SUPERGLAS

## EAGLE-PICHER has a FULL LINE of *Industrial and Commercial* INSULATIONS





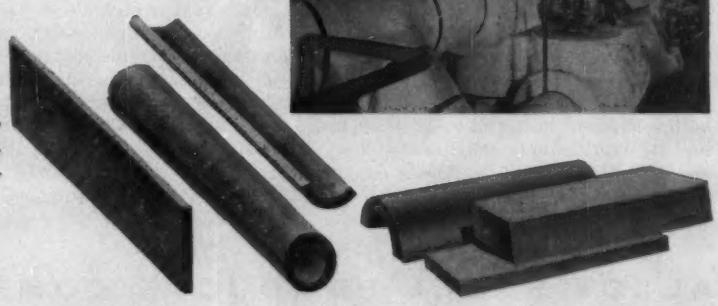
No matter what the application, there's now an Eagle-Picher insulation to do the job best. Choose the basic material you prefer—mineral wool, magnesia or Eagle-Picher's latest, SUPERGLAS. These materials give you a complete choice of pipe insulations, blocks, blankets, felts and cements.

### Superglas Insulations

Have low bulk, low application costs, few maintenance problems. Won't shrink, warp or buckle. Available in a wide variety of shapes, types, sizes, thicknesses and densities for pipe, duct and equipment installations. Effective at temperatures from minus 120 F to 400 F. Numerous finishes and facings for pleasing appearance in exposed installations.

### 85% Magnesia and Hylo Insulations

Extremely light weight with low conductivity, great strength and high dimensional stability. Easily workable, retains high thermal efficiency. Available in pipe section and blocks.





For more data on advertised products, use Readers' Service Cards, last page.

# Mineral Wool Insulations

These mineral wool and cement insulations provide maximum thermal efficiency for temperatures ranging from below zero to over 2000 F.

**PV SUPERTEMP BLOCKS** — an all purpose, true-cut block with *precision finish*. Combines efficiency, durability and great strength. Lightweight, easily installed, resists steam and other moisture.

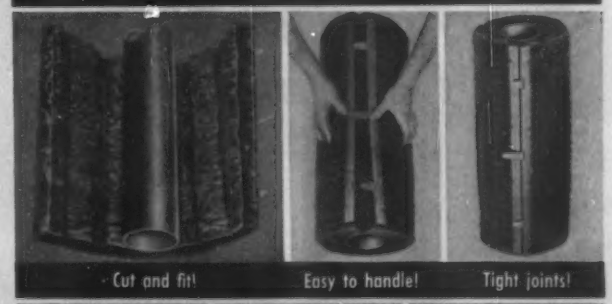
**BLANKETS**—factory fabricated to *rigid specifications*. Blankets are completely free of large voids. Smooth edges butt tightly together. For application to flat or slightly curved surfaces, can be cut to fit irregular areas.

**TAB-LOK**—a high temperature pipe insulation *easy to apply*. Precision made, tab-and-slot feature assures tight, close butted joints. Water-repellent, corrosion, fire, and vibration-resistant. No reinforcing needed. Saves time and labor.

**SUPER "66" CEMENT**—*sticks to hot or cold surfaces.* Makes difficult jobs easy. Maximum coverage with no reinforcing needed on applications up to 1½ inches thick. Special rust inhibitor prevents corrosion.

**ONE-COTE CEMENT**—one quick application *insulates, protects, finishes.* Clean, easy to handle. For indoor or outdoor application. Applied to hot or cold surfaces. Quick setting, resists rain and moisture two hours after application. Prevents rust.

*We will be glad to send you complete data on our comprehensive line of insulations for all industrial and commercial applications. WRITE TODAY!*



*Since 1843*

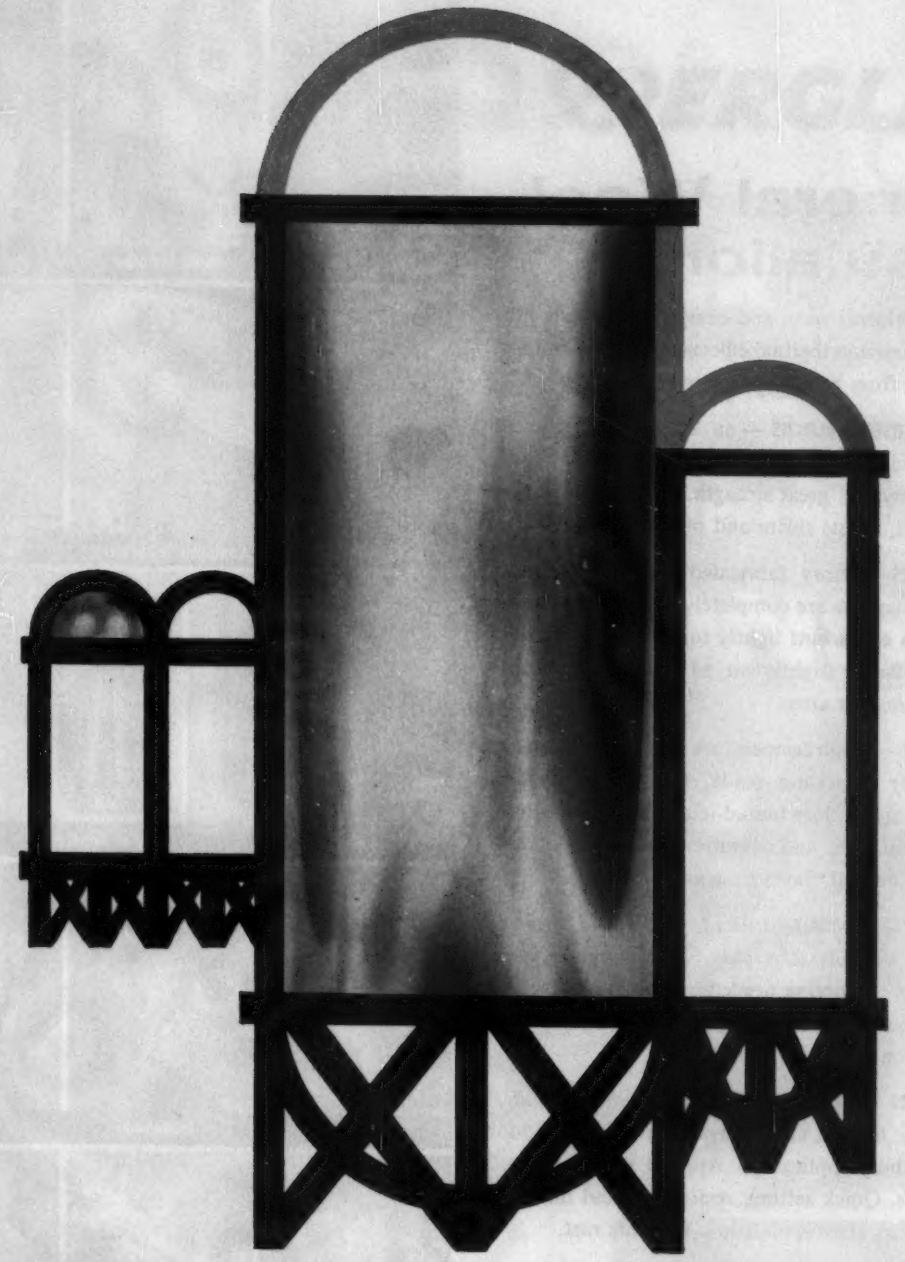
EAGLE PICHER

**EAGLE-PICHER**

**The Eagle-Picher Company**
**General Offices: Cincinnati 1, Ohio**



For more data on advertised products, use Readers' Service Cards, last page.



# win the fight against corrosion—with Alcoa Aluminum

Chances are the staggering cost of corrosion is your most serious headache. If so, don't overlook this important possibility: there is probably a known—and proved—economical aluminum answer to your most serious corrosion problem. Alcoa engineers can show it to you.

Alcoa's corrosion specialists have accumulated over 1000 man-years' experience applying aluminum to solve corrosion problems in the process industries. Their unequaled experience has produced an immense fund of factual data on the behavior of aluminum with corrosive materials and in corrosive atmospheres. That data is at your service.

Let Alcoa's engineers show you how to *win the fight against corrosion—with Alcoa® Aluminum.* Outline your corrosion problems in a letter to ALUMINUM COMPANY OF AMERICA, 905-D Alcoa Building, Pittsburgh 19, Pa.

"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Specify Alcoa Aluminum for
corrosion-free Process Equipment
Pipe & Tube
Tanks, Containers, Trucks & Cars
Plant Structures



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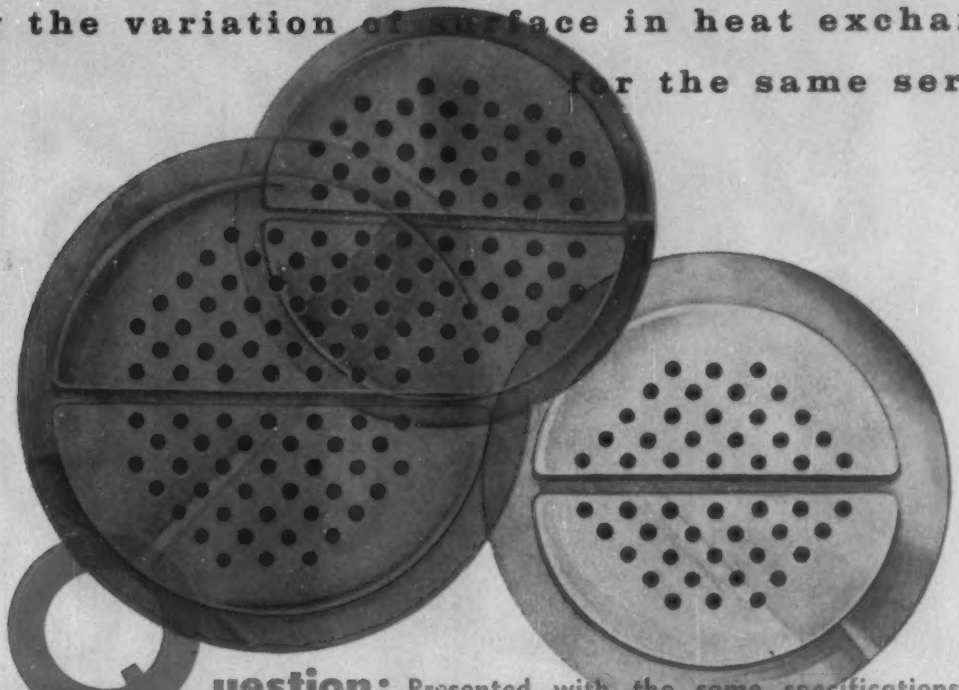
## Why the variation of surface in heat exchangers for the same service?



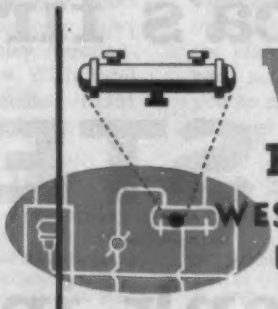
**Question:** Presented with the same specifications, what justification is there to the variation of surfaces offered by a number of reputable suppliers of heat exchanger equipment, for a given service?

**Answer:** Since heat transfer calculation to date is not an exact science, the data on which design curves are based may vary over a wide range, and EXPERIENCE is often the deciding factor, SO THAT . . . .

. . . . Western's years of experience in heat exchanger design, with both the small independent refiners as well as with the giants of the industry, are a great asset in helping you select the equipment you need for your *specific problem.*

Personal attention to detail and knowledge of customer preferences are integral in each Western-customer relationship. Utilizing the most modern methods and machinery in rating and fabrication results in achieving the highest heat transfer efficiency at realistic prices.

Western specifies the surface to fit your specific service — no more and no less.



**WESTERN**

**HEAT EXCHANGERS**

**WESTERN SUPPLY COMPANY**

**P.O. Box 1888 – Tulsa, Oklahoma**

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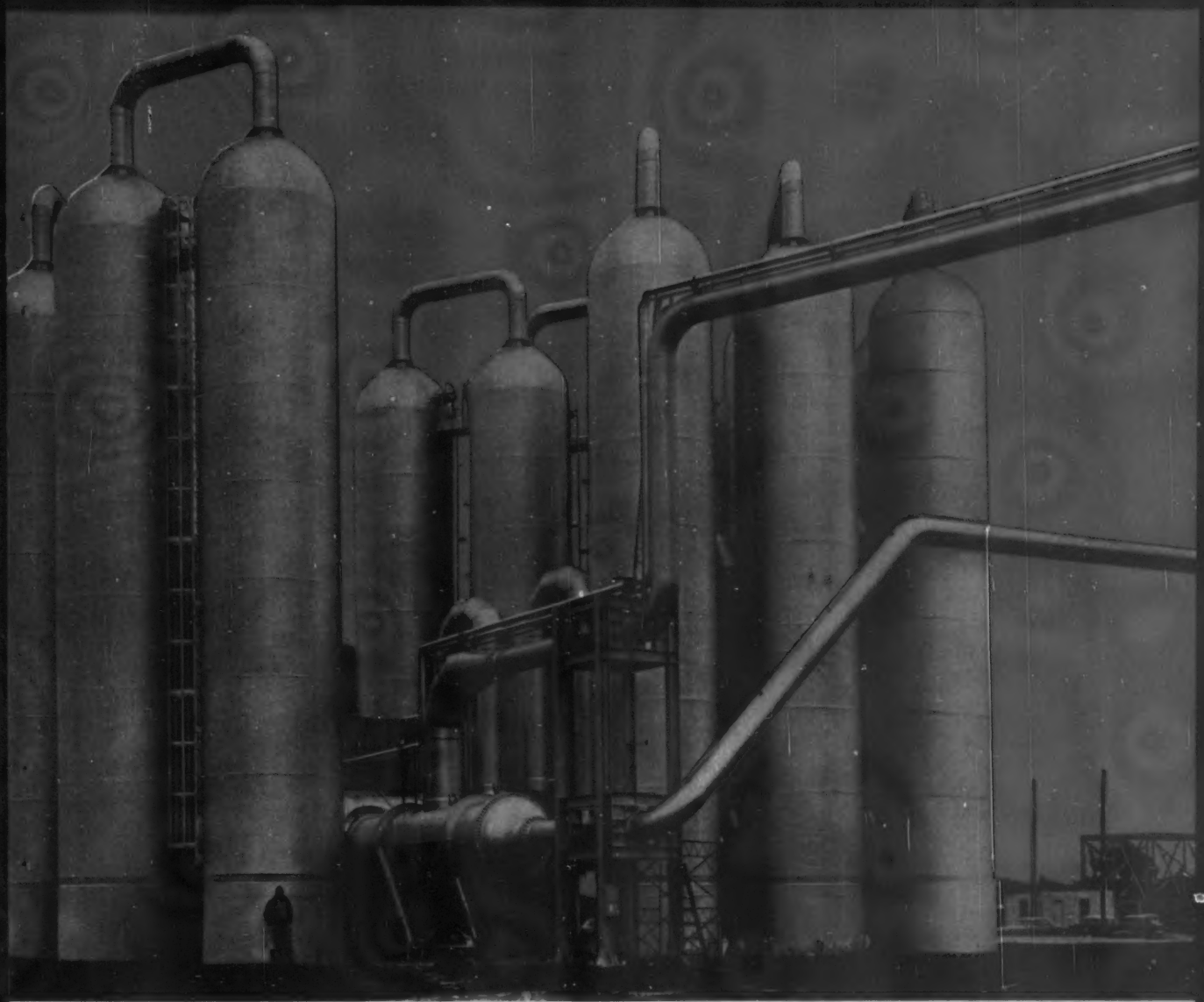
PIONEERING BY PDM

ENGINEERS · FABRICATORS CONTRACTORS

# America's first big

# T-1 STEEL

# pressure tank installation



## *12 tanks, each 63 ft high by 11 ft dia, storing air at 600 psia, for special research application*

This first-time application of T-1 high strength alloy steel to tanks working at high pressures has significance to every user of pressure vessels in the process industries. Researched, designed, fabricated and tested by Pittsburgh-Des Moines, the tanks supply air at 600 psia to a 20-inch supersonic blowdown wind tunnel at N.A.C.A.'s Langley Aeronautical Laboratory, Langley Field, Va. ● With total volume, pressure and ground area specified, PDM was required as a bidder to determine the most economical size and number of tanks to do the job. If made of standard boiler steel, the tank walls would have had to be extremely thick to contain the required pressure, and so our previous T-1 experience suggested the use of this high-strength alloy. Our own tests of workability and weldability confirmed the plan, and PDM was awarded the contract at a very substantial saving to N.A.C.A. ● We invite you to make use of our very extensive experience in the most exacting kinds of steel platework fabrication.

## Pittsburgh • Des Moines Steel Company

Plants at PITTSBURGH, DES MOINES, SANTA CLARA, FRESNO, and CADIZ, SPAIN

*Sales Offices at:*

PITTSBURGH (25) . . . . . 3482 Neville Island
NEWARK (2) . . . . . 1763 Military Park Bldg.
CHICAGO (3) . . 686 First National Bank Bldg.
EL MONTE, CAL. . . . . P. O. Box 2012
ATLANTA (5) . . . . 361 E. Paces Ferry Rd., N.E.
DES MOINES (8) . . . . . 983 Tuttle Street
DALLAS (1) . . . . . 1287 Praetorian Bldg.
SEATTLE (1) . . . . . Suite 390, 500 Wall St.
SANTA CLARA, CAL. . . . . 689 Alviso Road
DENVER (2) . . . . . 323 Railway Exchange Bldg.

"Personally, I always specify Lewin-Mathes Copper Tube"

*We welcome stiff-necked specifications.*

We meet them . . . because the copper we form into tube is first *refined by us* in our own plant.

We meet them . . . because Lewin-Mathes' *completely integrated operation* permits a standard of quality control—from raw material to packaged tube—that is unsurpassed anywhere in the industry.

As refiners, we know the copper going into Lewin-Mathes Tube is pure. As fabricators, we painstakingly control every physical and chemical property of the finished product. And as *integrated specialists*, we take pride in delivering every foot of Lewin-Mathes Copper Tube uniform and perfect . . . to meet your most exacting requirements.

*Nothing primitive* about Lewin-Mathes supply facilities. Our products are available through Wholesale Distributors, serviced by Lewin-Mathes Mill Depots throughout 48 states.

LEWIN MATHES
SAINT LOUIS, MISSOURI
COPPER AND BRASS TUBE PIPE AND ROD
DIVISION OF CERRO DE PASCO CORP.

A large perforated deck for a Gulf Coast Refinery.

# "custom made" to cut cracking costs!

Hendrick perforated column internals are tailored to your detailed specifications. Then they are fabricated from Hendrick's stock of commercially rolled metals in gauges selected by your own process designer.

Whether your column internal assemblies require perfectly round, square or slotted perforations, you can be sure Hendrick will meet every requirement with clean cut perforations that assure uniformity of mesh and long service life.

The result—you get greater fractionating tower capacity (up to 20% over trays of non-perforated design) and substantially reduced cleaning, replacements and downtime costs. Unit costs may be appreciably lower than non-perforated. Mail coupon for literature.

**Hendrick**
MANUFACTURING COMPANY

Perforated Metal • Perforated Metal Screens • Wedge Slot and Hendrick Wedge Wire Screens • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hendrick Hydro-Dehazer • Distillation Column Internals

Hendrick Manufacturing Company
36 Dundaff Street, Carbondale, Penn.

Gentlemen:

____ Please send me FREE literature

____ Send representative

Name_____ Title_____

Company_____

Address_____

City_____ State_____



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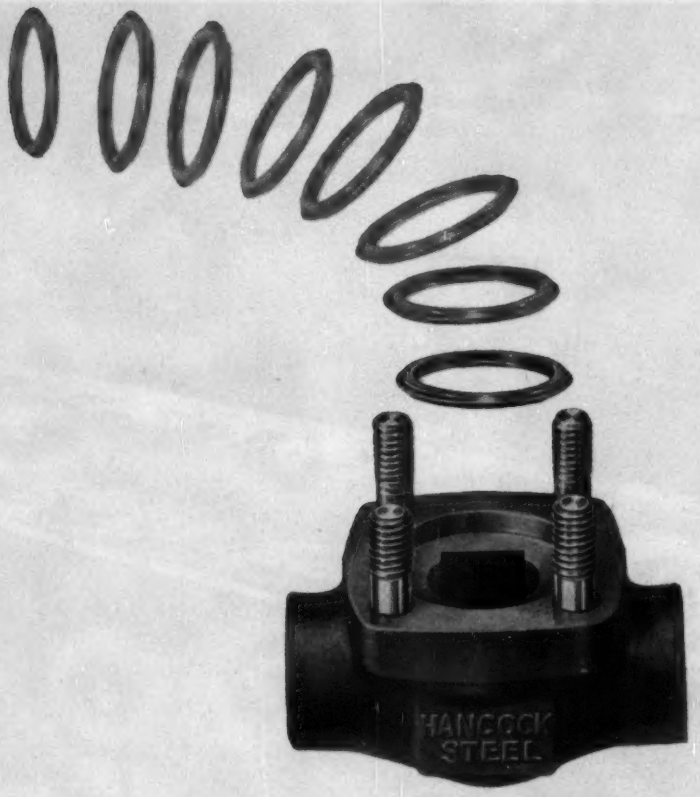
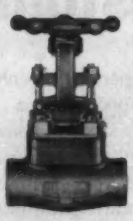



# RING OF STEEL

## Defies Pressure Times Ten

The Flexitallic gasket in the bonnet joint of Hancock Steel Gate Valves cannot blow out even if pressures exceed ten times the rating of the valve. Valve maintenance and equipment down-time are greatly reduced. Made of a spiral-wound ribbon of stainless steel with asbestos filler, the gasket has spring-like compressibility — cannot be flattened.

Only the specially-designed Hancock bonnet joint with built-in compression limit can make full use of the positive sealing power of this ring of steel. Such advanced valve engineering is one example of total Hancock quality that assures trouble-free performance. Your nearby industrial supply distributor will gladly explain every economy feature of Hancock Steel Gate Valves. Phone him today.



Hancock 800# Steel Gate Valve, Type 950. Sizes: ¼" thru 2".

MANNING MAXWELL & MOORE TRADE MARK

H3-58

***HANCOCK STEEL VALVES***

***A product of***

**MANNING, MAXWELL & MOORE, INC.**

*Consolidated Ashcroft Hancock Division • Watertown, Massachusetts*
*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



For more data on advertised products, use Readers' Service Cards, last page.

A hot steel circle ready for Claymont's 3000-ton head press. This precision machine is capable of hot or cold pressing heads up to 10 feet in diameter in a wide variety of metals. Integrated facilities make Claymont a reliable source of quality steel plate and plate products for industry.

*by d'Arazien*

# CLAYMONT PRESSED HEADS

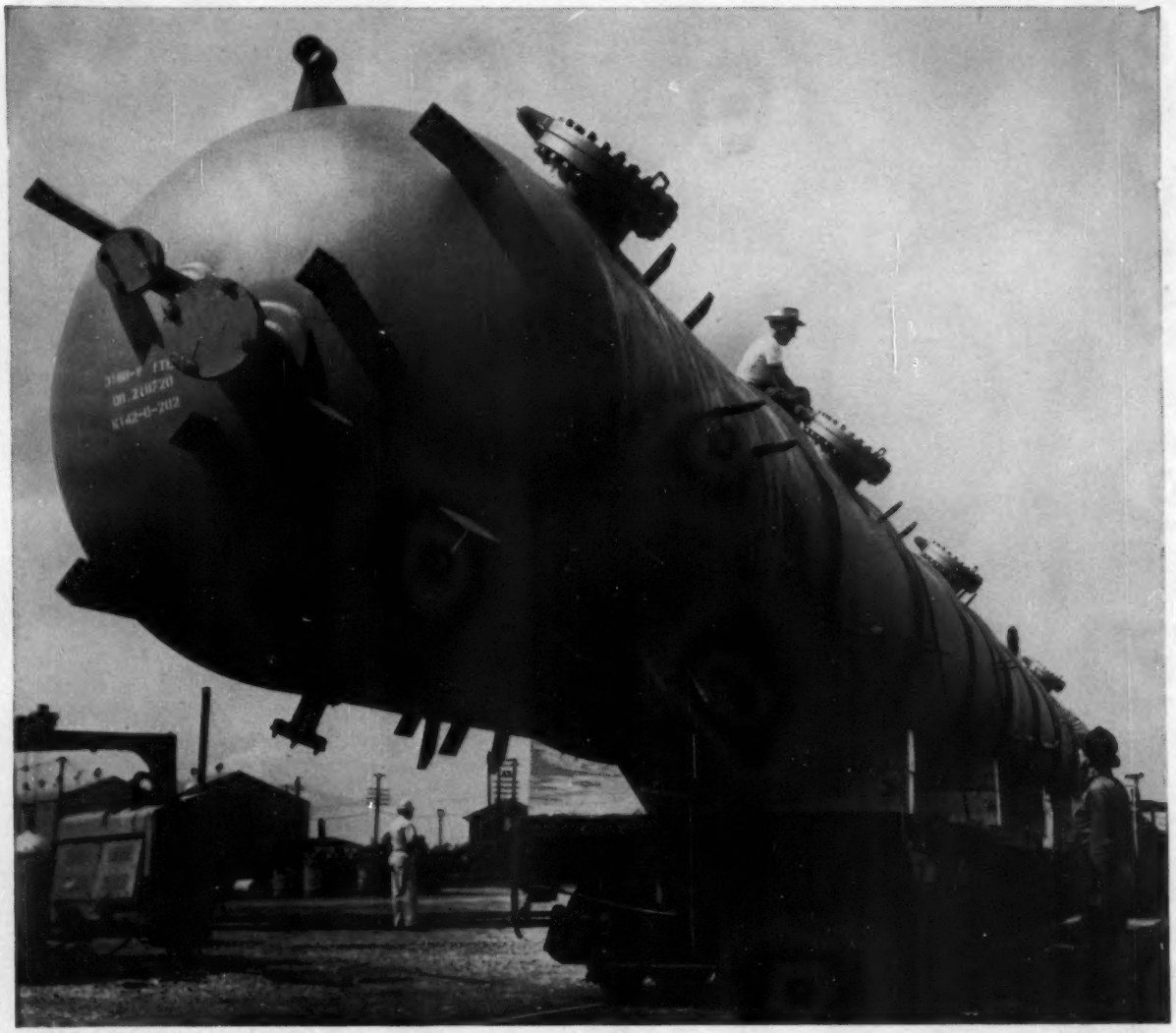
CF&I

**CHECK CLAYMONT FOR**—Alloy Steel Plates • Carbon Steel Plates • Stainless-Clad Steel Plates High Strength Low Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Pressed and Spun Steel Heads • Manhole Fittings and Covers • Fabricated Steel Products Large Diameter Welded Steel Pipe

**PRODUCTS OF WICKWIRE SPENCER STEEL DIVISION • THE COLORADO FUEL AND IRON CORPORATION**

Plant at Claymont, Delaware • Sales Offices in all Key Cities

5744



**THIS ENTIRE VESSEL** was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

# Among the largest in use

## ...built by Newport News

**This Debutanizer** with a 110 feet 6 inches over-all length is typical of units that are readily built by Newport News . . .

In fact, Newport News can fabricate almost any type of pressure vessel or other heavy equipment used in the petroleum, chemical or other processing industries.

But at Newport News you'll find more than large productive capacity.

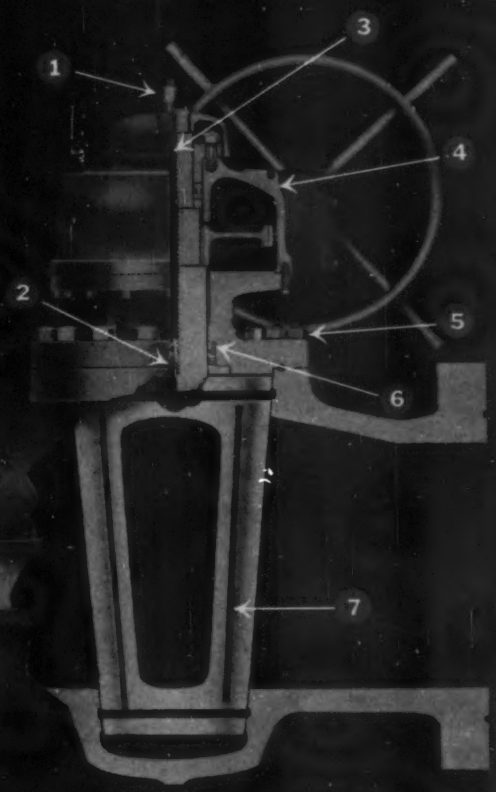
In vast fabricating shops, in huge machine shops, foundries and forging plants, Newport News craftsmen complete your order with specialized techniques. Plant methods . . . developed as a result of specializing for more than half a century . . . enable Newport News to provide money-saving answers to all sorts of heavy equipment problems.

Newport News craftsmen handle the job exactly as you want it done . . . for maximum results per dollar invested. So let us bid on your present or future projects. Learn how Newport News can help you. Send for our illustrated booklet entitled, "Facilities and Products"...it's yours for the asking.

**Engineers** – Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

**Newport News** Shipbuilding and Dry Dock Company
Newport News, Virginia

# 7 characteristics that make WALWORTH a better Lubricated Plug Valve




1. Valve can be lubricated with a Walworth High Pressure Lubricant Gun without removing lubricant fitting.

2. Double ball check valve prevents line pressure from getting into lubricant system.

3. Groove, cut part way up side of lubricating fitting, provides extra safety feature by allowing operator to note any tendency of lubricant to blow out before fitting is entirely removed.

4. For buried pipelines—gear housing design permits simple attachment of lubrication and handwheel extensions without modifying the gearcase.

5. Standard bolt threads, rather than fine threads, means easy replacement of nuts and bolts from local stocks.

6. Two overlapping Teflon* packing rings form an effective seal against possible leakage without "grabbing" the plug shank. Low break-out torque—plug turns easier.

7. Vertical and circumferential lubricant grooves completely frame the port openings, assuring a tight seal against leaks.

*Du Pont registered trade-mark

Cutaway of a 24-inch Walworth Lubricated Plug Valve

## you always know that a WALWORTH LUBRICATED PLUG VALVE will operate

**No matter when you need it, you can count on a Walworth Lubricated Plug Valve to operate easily and dependably in handling gas, crude or finished products. In petroleum service throughout the world, these valves have long proved their complete dependability and easy maintenance. Other Walworth products, designed and manufactured especially for the oil and gas industries, include Gate, Globe, Angle and Check Valves. Sold by distributors in principal centers throughout the world.**

**WALWORTH**

*750 THIRD AVENUE, NEW YORK 17, N. Y.*
*DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD*

***WALWORTH SUBSIDIARIES:*** ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.



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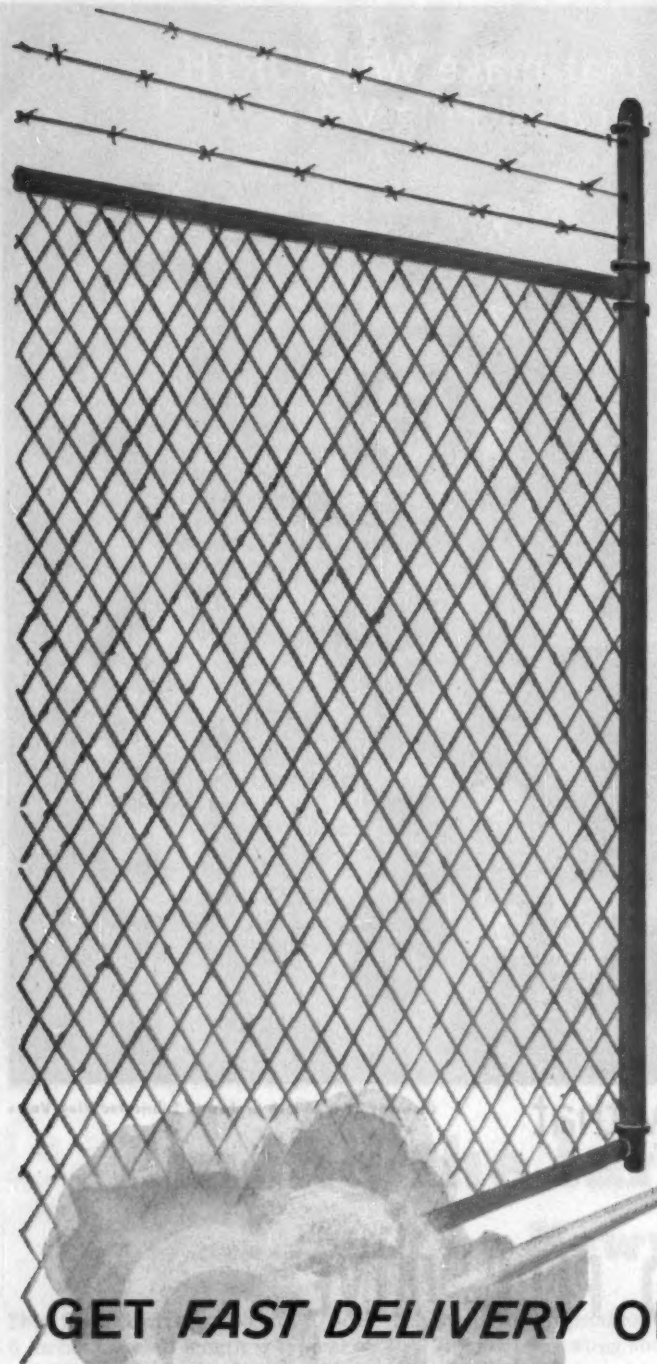


Wherever you are, there's a distributor of Nitrogen Division ethanolamines and ethylene glycols nearby. Why not make a note right now of the one nearest you.

Local stocks of ethanolamines and ethylene glycols are maintained by the following Nitrogen Division distributors for serving the oil and gas industry:

**Los Angeles Chemical Company,** South Gate, Calif. . . . **Cole & De Graff,** San Francisco, Calif. . . . **Mine & Smelter Chemical Company,** Denver, Colo. . . . **Acid Products Company, Inc.,** Chicago, Ill. . . . **Mid Continent Chemical Company,** South Bend, Ind. . . . **Coastal Enterprises, Inc.,** Abbeville, La. . . . **Southwest Gas Equipment Company,** Liberal, Kans. . . . **Thompson-Hayward Chemical Company in:** Des Moines, Iowa; Wichita, Kans.; Shreveport, La.; Oklahoma City, Okla.; Tulsa, Okla.; Dallas, Tex.; Houston, Tex.; Lubbock, Tex.; San Antonio, Tex. . . . **Monarch Chemicals, Inc.,** Minneapolis, Minn. . . . **Dyce Sales & Engineering Service Co.,** Billings, Mont. . . . **Harry A. Baumstark & Co.,** St. Louis, Mo. . . . **George S. Coyne Chemical Company,** Philadelphia, Pa. . . . **T. H. Baylis Company,** Providence R. I. . . . **Continental Chem. Company,** Paterson, N. J.

# GET *FAST DELIVERY* ON ETHANOLAMINES AND ETHYLENE GLYCOLS — ANYWHERE!

Allied Chemical

**Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements**

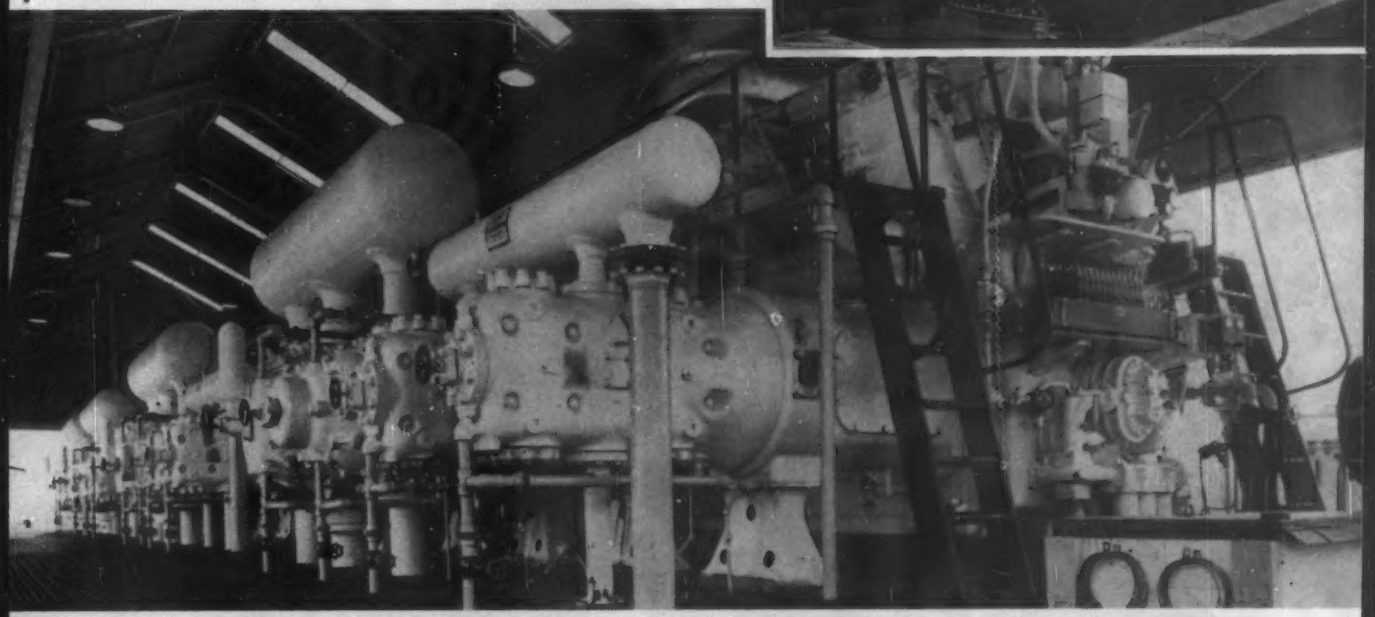
Nitrogen Division • Department GA 2-21-2 • 40 Rector Street, New York 6, New York



For more data on advertised products, use Readers' Service Cards, last page.

**A** *In the Fairbanks station of The Liquigas Company, a subsidiary of The Murmanill Corporation . . . three 8-cylinder Cooper-Bessemer GMVA's rated 1100 hp at 300 rpm and one 4-cylinder GMVA rated 540 hp at 300 rpm.*

**B** *Noted for "pulling ability", Cooper-Bessemer engine-driven compressors at Fairbanks deliver long-life service with minimum maintenance.*



# 99.35% AVAILABILITY

## with Cooper-Bessemer compressors at Liquigas

At the end of 24 months continuous operation, these four engine-driven Cooper-Bessemer GMVA compressors report a remarkable availability average of 99.35%.

Here, in the Fairbanks, Texas station of The Liquigas Company, tail gas is picked up at approximately 30 psig and boosted to 800 psig, then injected into pipeline at the rate of 20 million cubic feet per day.

The efficiency, economy and high availability of this modern compressor plant is typical of Cooper-Bessemer performance throughout the world. Because of this dependability and the continuing service of experienced Cooper-Bessemer personnel, you can readily see why more and more compressor jobs are going to Cooper-Bessemer. Get *complete* details for yourself. Contact the office nearest you, today.

*BRANCH OFFICES:* Grove City • New York • Chicago • Washington • San Francisco • Los Angeles • Houston • Dallas • Odessa • Pampa • Greggton • Seattle • Tulsa • St. Louis • Kansas City • Minneapolis • New Orleans • Shreveport

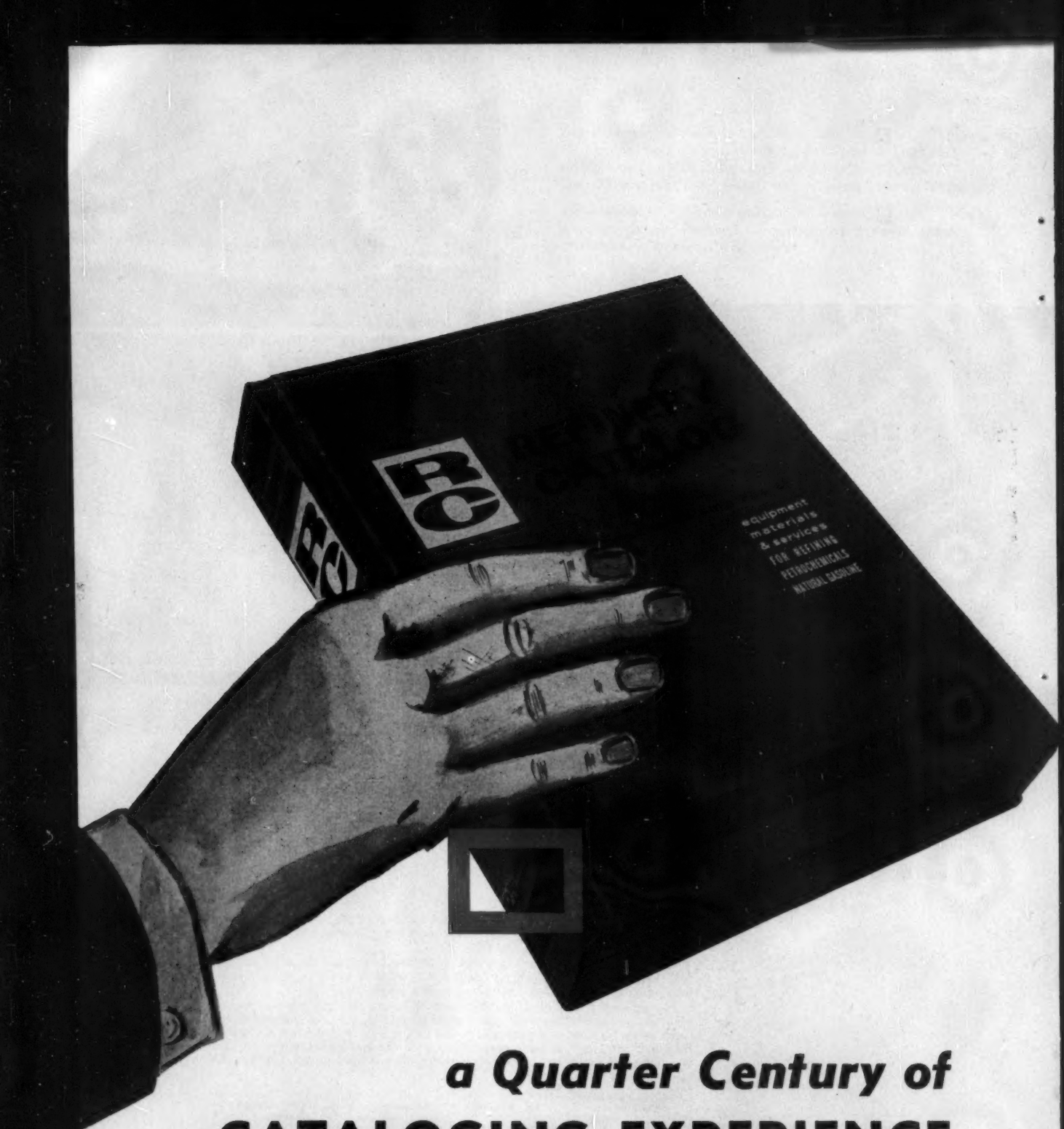
*SUBSIDIARIES:* Cooper-Bessemer of Canada, Limited . . . Edmonton • Calgary • Halifax

Cooper-Bessemer International Corporation . . . New York • Caracas • Mexico City

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL, ENGINE OR MOTOR DRIVEN

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# CATALOGING EXPERIENCE

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## The Most Complete Source for:

# EQUIPMENT-SERVICE DATA

in

# *Refining*
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**Every year for a generation executives, engineers and purchasing agents in the refining, natural gasoline and petrochemical industry have found Refinery Catalog a little more complete, a little more informative and easier to use. Preferred eight-to-one over individual sales and service bulletins, RC is the only detailed one-volume reference for complete or condensed manufacturers' catalogs, specifications, services, sources of supply.**

**It's conveniently indexed and cross-referenced to save you time and eliminate error. Over 300 manufacturers, suppliers and service companies listed.**

*you can meet any lubrication specification if you*

# BLEND WITH ENJAY PARATONE®

**(VISCOSITY-INDEX IMPROVERS)**

Base stocks blended with Enjay Paratone can be compounded into lubricants combining cold-weather quick starting properties with high temperature, low consumption characteristics. These lubricants are *all-season* oils, featuring improved gas mileage. More and more refiners and blenders are relying exclusively on Paratone to produce the high "VI" required in these all-season oils.

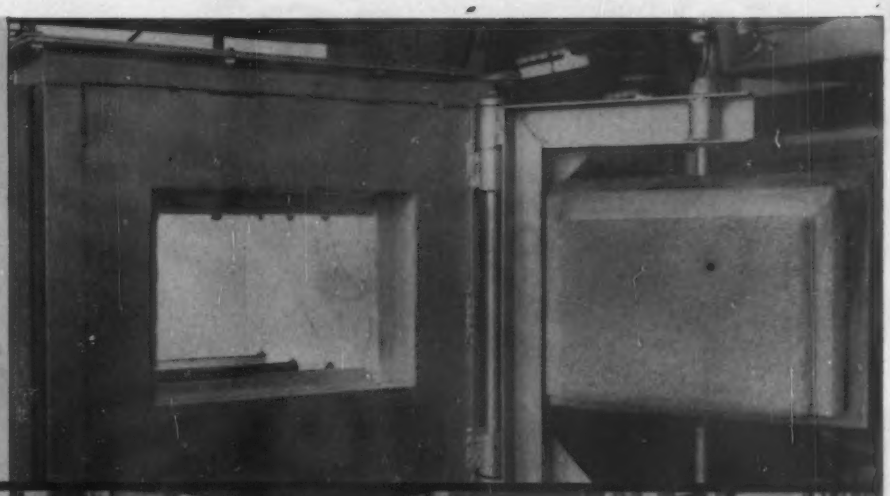
Through years of intensive research and development work with automotive manufacturers, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Write, wire or phone the Enjay Company.

ENJAY

*Pioneer in Petrochemicals*

**ENJAY COMPANY, INC.. 15 WEST 51st ST., NEW YORK 19, N. Y.**

*Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa*



**LINED WITH ALUNDUM 33-I CASTABLE,** this furnace has been used for almost a year as a periodic furnace for high-temperature laboratory test work. During this time the door was opened and closed over a thousand times with the furnace at temperature. Even after this rugged service, the ALUNDUM Castable lining shows hardly any signs of wear.

**LINED WITH A COMPETITIVE HIGH GRADE INSULATING BRICK,** this similar furnace was used in the same service for an equal length of time. Under equally severe thermal shock conditions the lining cracked and spalled and this furnace must be rebuilt.

# You get higher temperature protection with ALUNDUM* castables

## *Up to 3300° F!*

**ALUNDUM 33-I Insulating Castable** is made up primarily of countless tiny, pure aluminum oxide bubbles. Forming a network of air spaces it provides excellent insulation, even at the highest commercial temperatures.

**ALUNDUM 33-HD Heavy Duty Castable** is chiefly composed of dense grains of pure aluminum oxide. It is recommended for forming dense monolithic surfaces in constructing many types of furnaces where high temperature conditions are more severe.

**Both ALUNDUM 33-I and 33-HD Castables** protect at temperatures up to 3300° F and are very easy to mix and use. You can cast simple or complex shapes with them quickly and inexpensively for many installations and replace more expensive pre-fired shapes.

See your Norton Representative for more facts on how these new Castables can provide long, trouble-free service that saves you time and money. Ask him for the folder *Two New Norton Castables*, or write for your free copy to NORTON COMPANY, Refractories Division, 463 New Bond St., Worcester 6, Mass.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

**NORTON**

**REFRACTORIES**

*Engineered... Rx ...Prescribed*

*Making better products... to make your products better*

**NORTON PRODUCTS:**
Refractories • Abrasives
Grinding Wheels • Grinding Machines
**BEHR-MANNING DIVISION PRODUCTS:**
Coated Abrasives • Sharpening Stones
Behr-cat Tapes



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# Solution: Specify Time-Tested PITT CHEM *Insul-Mastic*

SELECTION of a durable, heavy-duty moisture and vapor seal was an important consideration in planning the corrosion and insulation protection of five 40,000-barrel spheroid butane tanks at a large East Coast refinery.*

Because of its long record of maintenance-free service in the petroleum industry, Pitt Chem *Insul-Mastic* Gilsonite coating was specified for the job. Foam glass type insulation blocks were imbedded in *Insul-Mastic* #4010 Vaporseal. The same material was used for all joints and sprayed as a final weather sealing coat to protect the efficiency of the insulation and prevent corrosion of the metal structures. A glass membrane was imbedded in the weather sealing coat to assist in withstanding structural movement. Geo. V. Hamilton, Inc., Pittsburgh, was contractor for the job.

Pitt Chem *Insul-Mastic* coatings have no equal in stopping moisture vapor penetration. Unlike ordinary asphaltic coatings, they contain *Gilsonite*, one of the most chemically resistant bitumens known. They withstand extremes of heat and cold, moisture and dryness, expansion and contraction.

Specify Pitt Chem *Insul-Mastic* for *your* next corrosion-proofing or vapor sealing job. You'll be using the same protection applied to many hundreds of pieces of equipment in the petroleum industry, many of which have been *Insul-Mastic*-protected for nearly two decades with little or no maintenance cost.

Pitt Chem *Insul-Mastic* Coatings are available through your local industrial distributor. Call him today for more information, or write direct for a Pitt Chem Corrosion Protection Guide.

*Name on request.

*Think First of the Coatings that Last!*

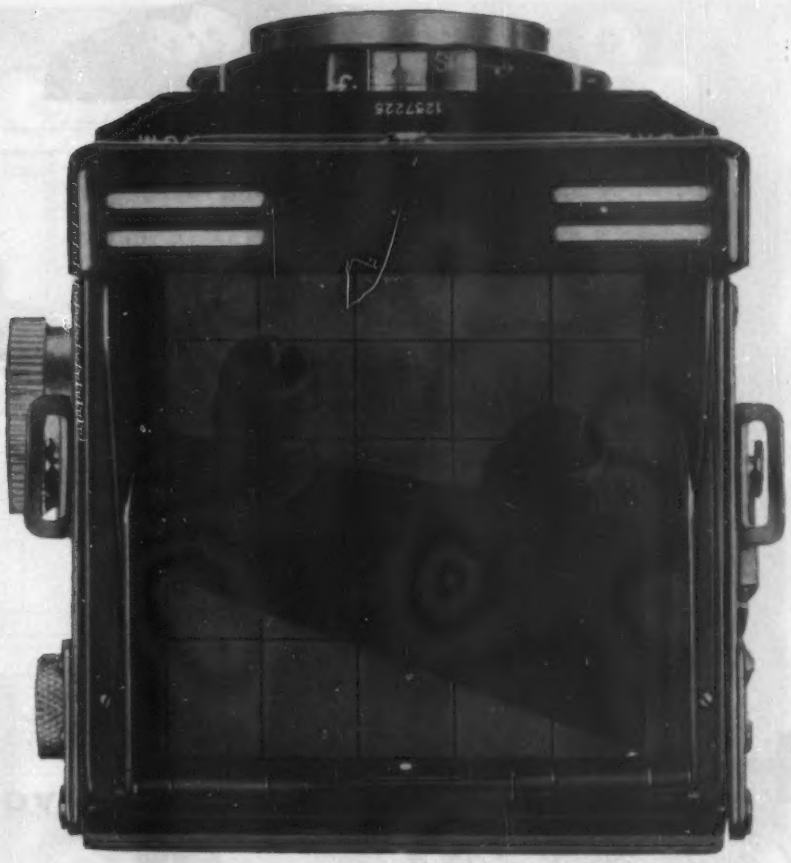
**PITT CHEM**
**Coal Tar Coatings**

**PITT CHEM**
**"Insul-Mastic" Gilsonite Coatings**

**PITT CHEM**
**"Tarset" Coal Tar Epoxy Coating**

PITT CHEM Industrial Coatings are available through leading Industrial Distributors. See the "Yellow Pages."

COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON



# keep gum formation out of the picture with....Tenamene

EASTMAN GASOLINE ADDITIVES

Protect the full power you build into your aviation gasolines with gum-inhibiting Tenamene additives.

The Tenamene line includes every principal type of gum inhibitor in commercial use today.

The quality and uniformity of the Tenamene additives are assured since Eastman manufactures all of the gasoline additives it supplies and exercises precise control over every step in the manufacture of them.

On-the-spot technical service is available from qualified Eastman petroleum specialists to help you achieve maximum performance from these dependable additives.

For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

**SALES OFFICES: Eastman Chemical Products, Inc.,** Kingsport, Tennessee; New York City; Framingham, Mass.; Cincinnati; Cleveland; Chicago; St. Louis; Houston.
**West Coast: Wilson Meyer Co.,** San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.



For more data on advertised products, use Readers' Service Cards, last page.

# HF won't bite... if you treat it right

*Careful control is the answer*

**Hydrofluoric acid can be as safe** as many other active chemicals commonly used today . . . when it's handled right. And it offers new economies as a catalyst you'll want to consider when you expand alkylation capacity.

**Pennsalt will help you make HF safer with this control.** We're ready to give you expert technical aid on handling and storing HF . . . help you set up employee training programs . . . answer your questions on piping, valves and other equipment and materials that are best for HF service. We know how to make this useful chemical safer because we've been working with it for years.

**Pennsalt specializes in HF.** We've pioneered and led in fluoro-chemistry for over 40 years . . . have continuously developed ways to produce, ship and handle it better and safer. Pennsalt HF is made in modern plants. Its quality is carefully controlled to assure purity that meets or betters alkylation process needs. It is available in cylinders and tank cars of convenient sizes.

**Get the benefits of HF now.** HF alkylation pays off in lower catalyst cost per barrel of alkylate, shortens reaction time and catalyst settling time, eliminates spent acid problems, reduces acid inventory. Why wait for these savings? Call or write Pennsalt today to get the *facts* on HF.

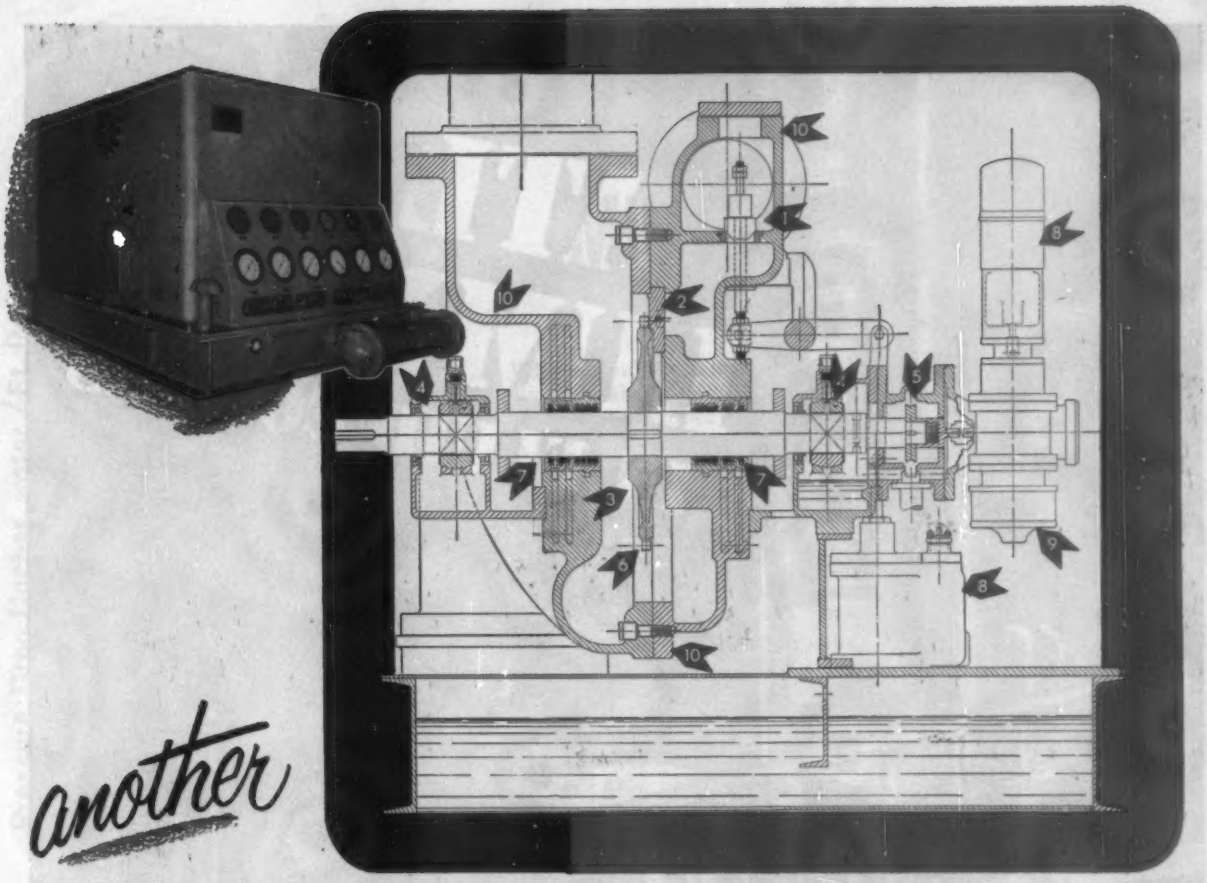
*See our Catalog in CMC*

Pennsalt Chemicals
ESTABLISHED 1850

INDUSTRIAL DIVISION
**PENNSALT CHEMICALS CORPORATION**
3 Penn Center, Philadelphia 2, Pa.

Chicago • Detroit • New York • Philadelphia • Pittsburgh • St. Louis • Appleton • Cincinnati • Atlanta
Airco Company International, New York • Pennsalt Chemicals of Canada Ltd., Oakville, Ontario

In the West, Pennsalt inorganic chemicals are available through Pennsalt of Washington Division, with plants at Tacoma, Washington and Portland, Oregon.




*another*

## MURRAY INSIDE STORY . . . OR WHY MURRAY EXCELS FOR MULTI-VALVE COMPRESSOR DRIVE

1. Multiple automatic bar-lift inlet valves.
2. Stainless steel nozzle block.
3. Specially shaped forged alloy steel disc and shaft — separate or integral.
4. Spherical seated, pressure lubricated sleeve bearings.
5. Kingsbury thrust bearing.
6. Special integral spacer type accurately formed stainless steel blades.
7. Carbon or labyrinth type gland seals.
8. NEMA Class D precision oil relay governor with hydraulic servomotor.
9. Positive displacement, shaft driven lubrication oil pump.
10. Heavy duty, rugged construction throughout.

Our nearest representative will help you solve your turbine requirements. His name gladly sent on request.

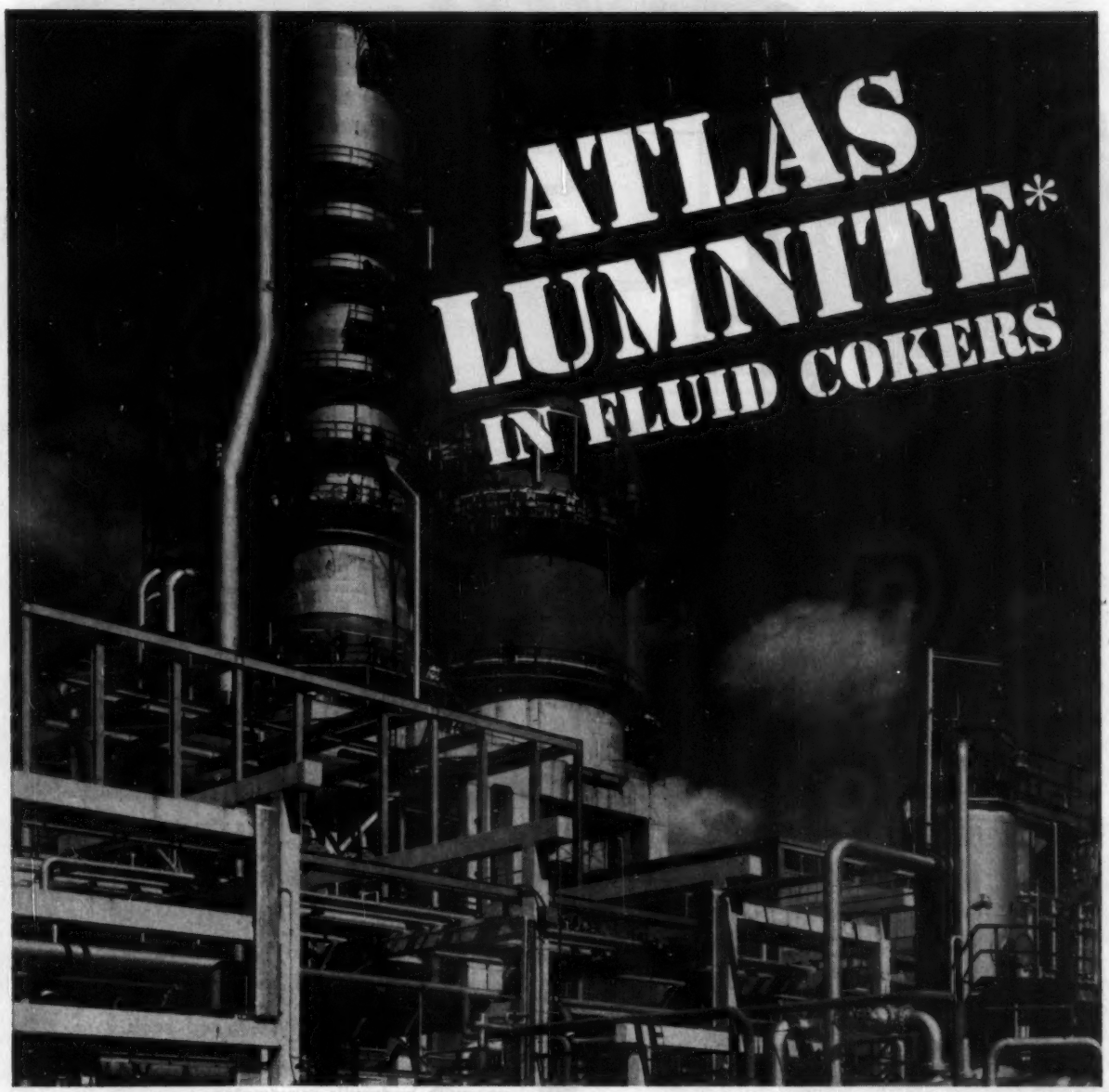
# Murray TURBINES

**MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA**

Builders of Steam Power Equipment for Nearly a Century



For more data on advertised products, use Readers' Service Cards, last page.




42,000 B/D coking unit whose major vessels are lined with "Resco Cast RS-3" insulating refractory castable made with LUMNITE cement. Tidewater Oil Company, Delaware Refinery. Engineers & Constructors: C F Braun & Co, Alhambra, California. Castable Manufacturer: Refractory Specialties Co., Philadelphia, Pennsylvania.

**resists heat . . . combats corrosion . . . insulates**

- Industrial concrete linings (made with LUMNITE cement and suitable aggregates) help solve heat, corrosion and insulation problems in vital refinery equipment.
- Shutdowns due to installation (or repairs) are minimized because placement is fast and easy – service strength is reached within 24 hours.

For maximum convenience, use castables made with LUMNITE cement. These are packaged mixtures, ready for use. Just add water, mix and place. Made and distributed by leading manufacturers of refractories.

For your copy of the "Lumnite Mortar Manual," describing gun-applied linings, write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

UNIVERSAL ATLAS CEMENTS

USS TRADE MARK

*"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company*

L-167

**UNIVERSAL ATLAS CEMENT COMPANY**—member of the industrial family that serves the nation—**UNITED STATES STEEL**

**OFFICES:** *Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco*

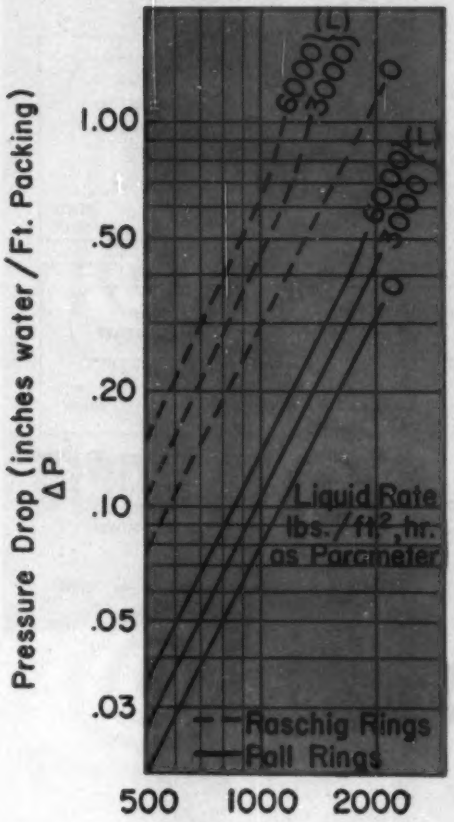


**For more data on advertised products, use Readers' Service Cards, last page.**

# Cut Tower Volume 20% to 40%

with

# METAL PALL RINGS




PRESSURE DROP vs. GAS RATE

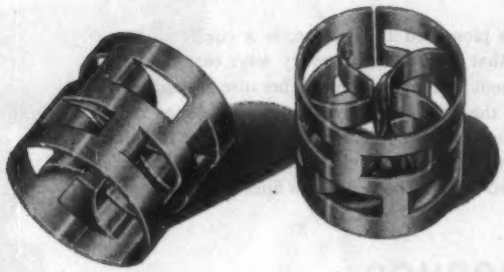
Where conditions suggest the use of metal packing rings in absorption operations, here's an important point to remember:

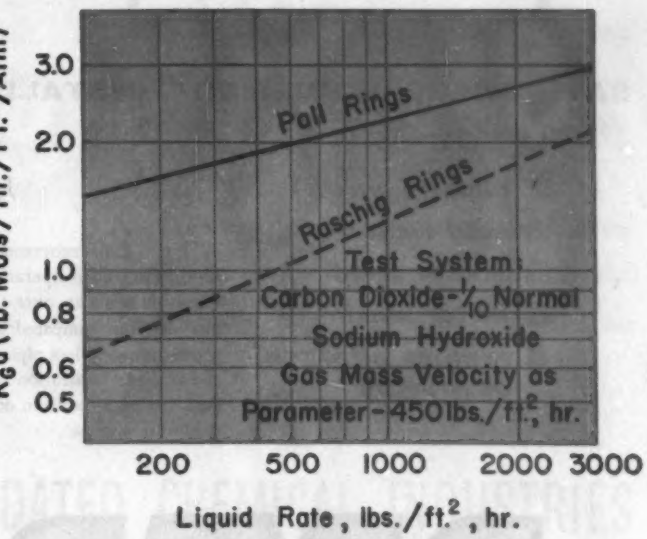
**Tower volume can be reduced substantially by using metal Pall Rings in place of metal Raschig Rings.**

Take a careful look at the graphs. They show capacity data and pressure drop data taken from tests run not in an eight or twelve inch tower but in our new 30" diameter experimental tower. The tests were made using 1½" rings, packed to a depth of 8 feet.

This improvement in performance results purely from the characteristics of the Pall Ring. The Pall Ring differs from the conventional Raschig Ring in that sections of the ring wall are stamped and bent inward permitting better circulation of liquid and gas. Thus, more surface area is wetted resulting in greater active contact area between phases.

Metallic Pall Rings are made at present in 1", 1½" and 2" sizes in carbon steel, stainless steel, aluminum and copper.






MASS TRANSFER COEFFICIENT vs. LIQUID RATE

**For full information —**

on Pall Rings and on other tower packings, write for a copy of Bulletin TP-54.

**U. S. STONEWARE**

**AKRON 9, OHIO**

101-P

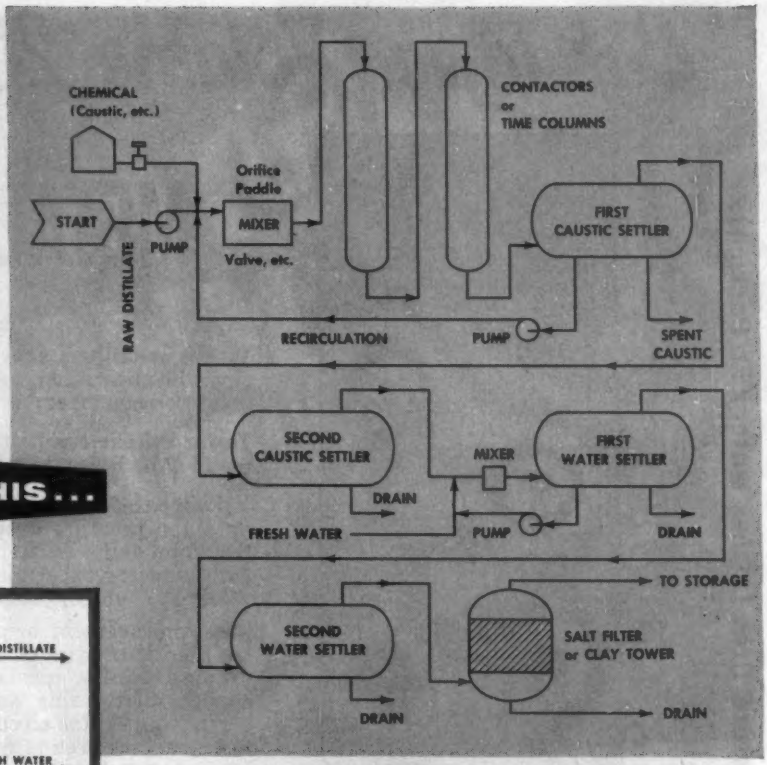


For more data on advertised products, use Readers' Service Cards, last page.

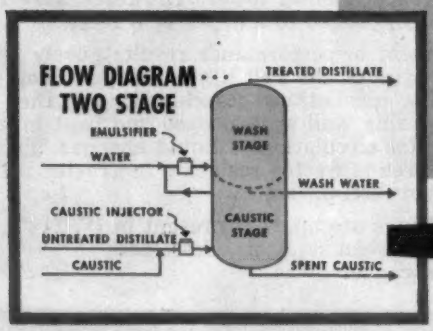
*with*

# PETRECO

## *ELECTROFINING on the job*




**YOU CAN CHANGE THIS...**




**...TO THIS**

## SAVE SPACE, EQUIPMENT, INSTALLATION COSTS

**IF YOU**

- ***caustic wash***
- ***acid treat***
- ***doctor treat***
- ***water wash***
- ***remove nitrogen or arsenic***

ELECTROFINING, as pioneered by Petreco, is a continuous, precision-controlled operation that is superior in every way: easier, because it affords efficient, once-through treatment; cheaper, because it requires but one vessel as compared with the 3 or 4 in conventional systems, as well as proportionately less piping, pumps or ground area; faster, because it delivers sharp, clean separation of hydrocarbon and chemical reagent-wash phases, cuts settling time from days to hours. The result is a finer finished product, ready for market.

# PETRECO

A DIVISION OF PETROLITE CORPORATION

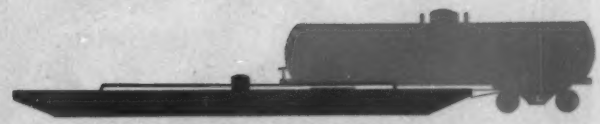
3202 SO. WAYSIDE DRIVE, HOUSTON 1, TEXAS • 1390 E. BURNETT STREET, LONG BEACH 7, CALIF.

*Specialized Petroleum Treating Processes and Equipment*

DESALTING • DEHYDRATING • DISTILLATE TREATING • SWEETENING • LUBE OIL TREATING • SEDIMENT REMOVAL

DT-58-5

# let Consolidated handle your sludge acid



## DISPOSAL PROBLEM ?

Consolidated Chemical Industries will take your sludge acid and return it to you as fresh, white, 99% sulphuric. Costly? Just the contrary — you'll turn a liability into an asset. Acid recovery is good business for *everybody*.

Such a service is typical of the technical facility in heavy chemicals developed by Consolidated in almost 40 years of pioneer development in the Gulf Southwest. Whether your requirement is for new acid or recovery of spent acids, Consolidated can serve you through one of its five plants, favorably located for road, rail or water shipment.

Get shipping, price and delivery data. Then turn your acid requirements over to the Southwest's leading producer. You'll like doing business with Consolidated.

Stauffer CHEMICALS SINCE 1885

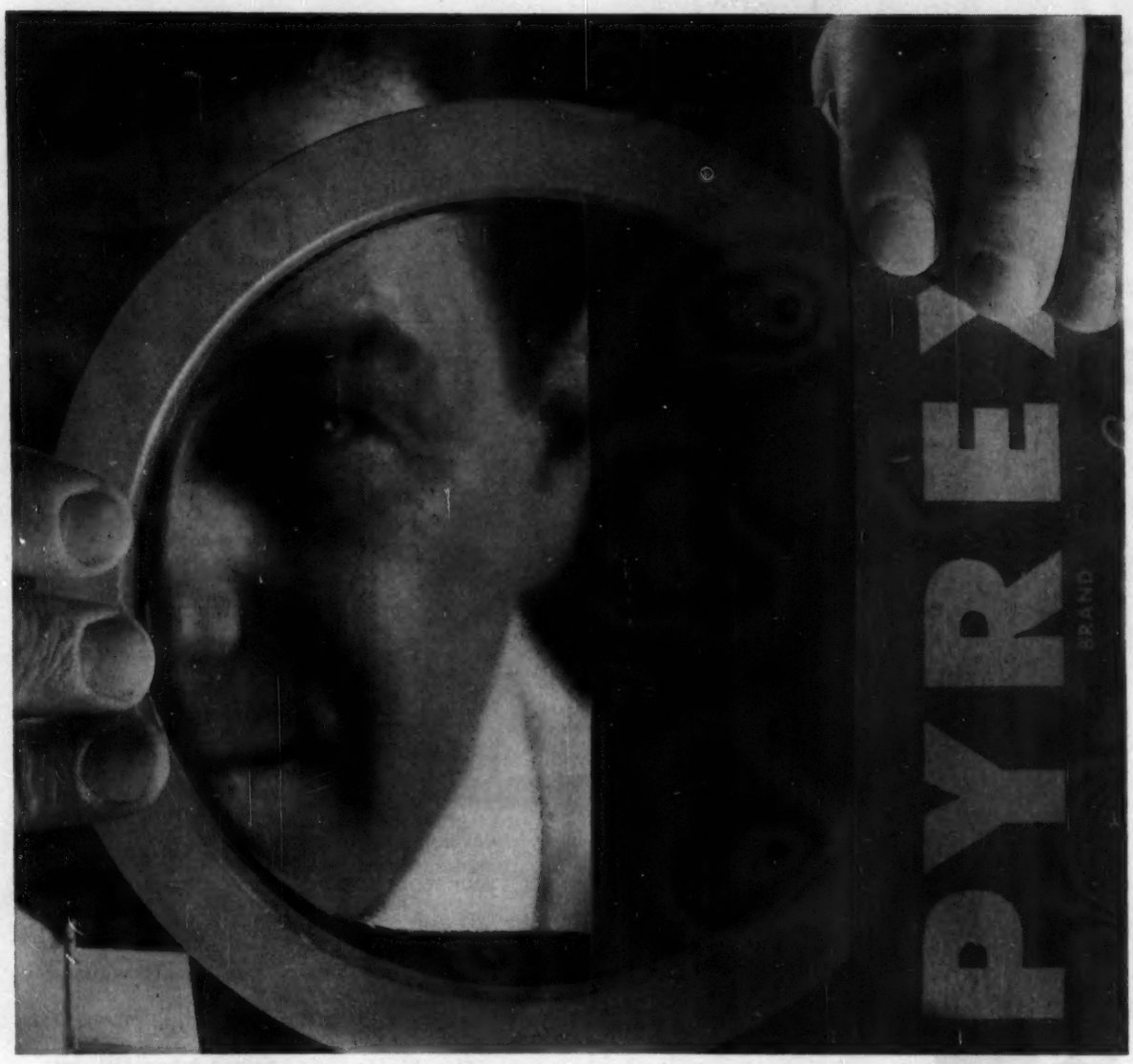
CCI

## CONSOLIDATED CHEMICAL INDUSTRIES

DIVISION OF STAUFFER CHEMICAL COMPANY

6910 Fannin St.
Houston 25, Texas

380 Madison Avenue
New York 17, N. Y.




# How this sight glass stays "good as new" . . . even after *months* of hard abuse

**Need to see what goes on *inside* your equipment? Then you need a glass window that can take it!**

Try a PYREX brand sight glass.

It's no ordinary glass — PYREX brand sight glass can take temperatures up to 500°F., pressures up to 300 p.s.i. A quick temperature change won't break it. Mechanical shock, corrosion, and abrasion don't harm it.

And through it all it stays clear. It remains transparent without clouding and pitting for a long service life.

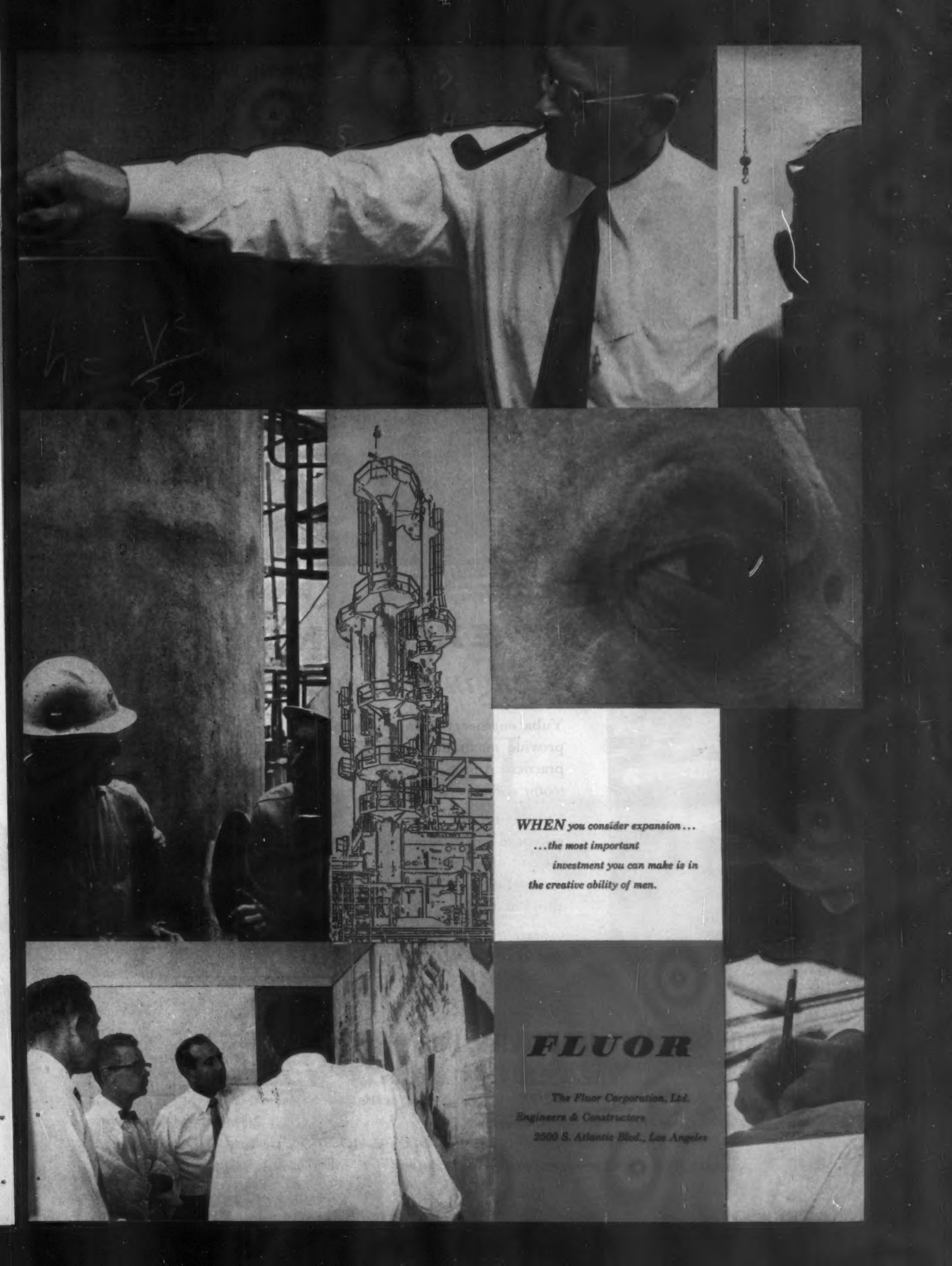
Use trouble-free PYREX brand sight glasses on ovens, absorption columns, reaction kettles, furnaces, pressure vessels, evaporators, stills, or processing tanks. They're available in a complete range of sizes for all applications.

Ask your regular mill supply dealer for more information — or write us for your copy of Bulletin EB-20. It gives complete specifications of PYREX brand sight glasses with mounting recommendations.

(Corning also makes PYREX®, CORNING®, and MACBETH® gauge glasses. They last longer, because they are made better. There's one to fit *every* gauge. Your distributor has them.)

*Corning means research in Glass*

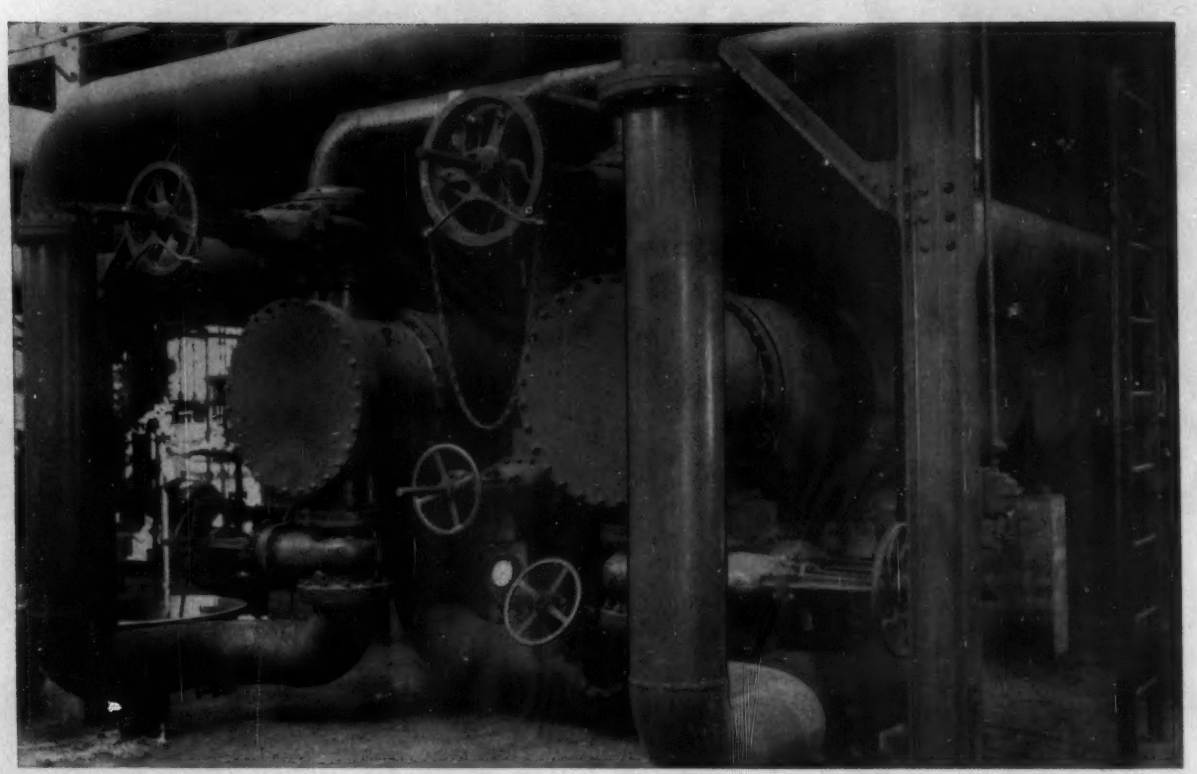
**CORNING GLASS WORKS,** 14-4 Crystal Street, Corning, N.Y.



*WHEN you consider expansion...*
*...the most important*
*investment you can make is in*
*the creative ability of men.*

**FLUOR**

*The Fluor Corporation, Ltd.*
*Engineers & Constructors*
*2500 S. Atlantic Blvd., Los Angeles*



Two 31" x 19' 4" heat exchangers, with 1800 sq. ft. of heating surface each, installed in the plant of a large Eastern coke and coal chemicals company. In them, flushing liquor from the coke ovens heats a carbonate solution used in a special process for eliminating hydrogen sulphide from manufactured gas.

# YUBA HEAT EXCHANGERS...

## *Engineered to Requirements*

Yuba engineers scientifically rate and design heat exchangers to provide maximum heat transfer consistent with good operating practice. And to help rate these exchangers, Yuba has an electronic computer to make the *best* selection from many possibilities.

Yuba's superior engineering insures that initial cost of equipment is kept to a minimum. Proper design means low maintenance, with the end result a profitable operation. You will find Yuba's plants in the East and West thoroughly experienced in working with alloys as well as with time-tested carbon steel.

***Contact the nearest office of our nationwide sales organization today and let us give you a quotation.***

**YUBA CONSOLIDATED INDUSTRIES, INC.**

351 CALIFORNIA STREET, SAN FRANCISCO 4, CALIFORNIA

*Divisions Manufacturing Heat Exchangers*

**YUBA HEAT TRANSFER DIVISION**
Honesdale, Pennsylvania

**YUBA MANUFACTURING DIVISION**
Benicia, California

YUBA

*San Francisco Sales Office:*
*520 Balfour Building*

*New York Sales Office:*
*530 Fifth Avenue*

Sales Offices and Representatives in Principal Cities



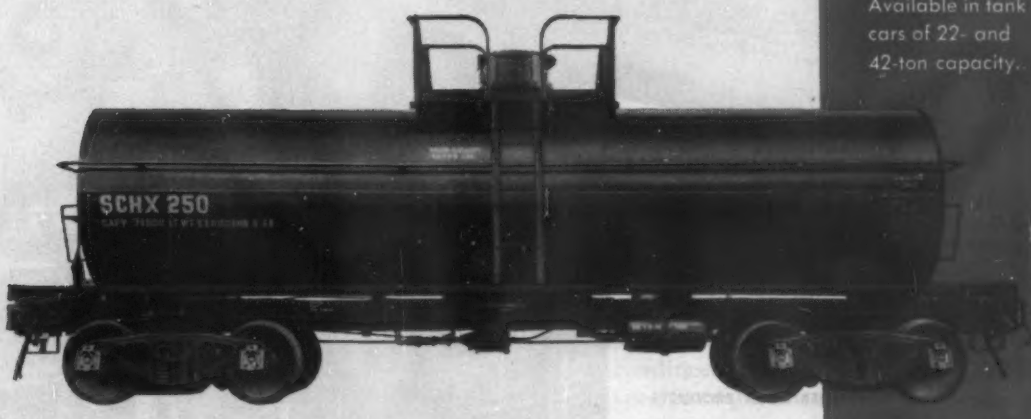
For more data on advertised products, use Readers' Service Cards, last page.

# HF

## HYDROFLUORIC ACID

*anhydrous and aqueous*

## STAUFFER HAS IT...
## IN QUANTITY AND QUALITY




Available in tank cars of 22- and 42-ton capacity.

**STAUFFER CHEMICAL COMPANY**

**380 Madison Avenue, New York 17, N.Y.**

**Prudential Plaza, Chicago 1, Ill. • 636 California Street, San Francisco 8, Calif.**

**NYOTEX CHEMICAL DIVISION, P.O. Box 9716, Houston 15, Tex.**

Stauffer CHEMICALS SINCE 1885



For more data on advertised products, use Readers' Service Cards, last page.

"OUT IN THE OPEN"

Vogt

# Steam Generators

for

CHEMICAL PLANTS

and

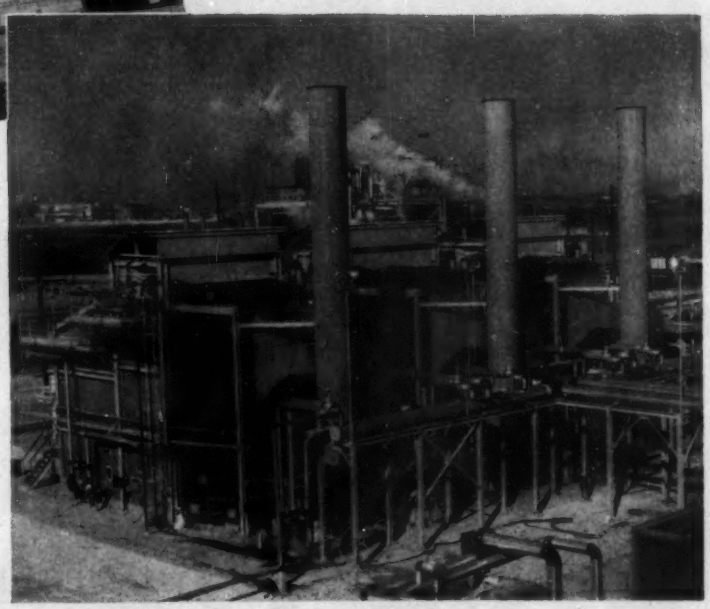
PETROLEUM REFINERIES

STEAM GENERATORS for economical outdoor operation have been featured by Vogt for many years and serve leading chemical plants and petroleum refineries. Requiring no building for housing, such installations, as pictured here, produce more steam per dollar of investment and are a definite aid to lower production costs.

Get Vogt's recommendations for steam generators to meet your needs for power, processing, or heating, without obligation. Package type and custom built units are available in a wide range of types, capacities, and pressures to meet operating requirements.

***Write for bulletins. Dept. 24A-BPR***

*Three 85,000 #/hr. steam generators in a Texas refinery.*



*An outstanding chemical plant served by three 150,000 #/hr. units.*

**OTHER VOGT PRODUCTS**

**Drop Forged Steel Valves, Fittings and Flanges — Petroleum Refinery and Chemical Plant Equipment**
**Heat Exchangers**
**Ice Making and Refrigerating Equipment**

**HENRY VOGT MACHINE CO., LOUISVILLE, KY.**

Sun Oil Co. cracking unit at Marcus Hook, Pa.

# B&W Carbon Monoxide Boilers Slash Millions in Operating Costs

B&W Carbon Monoxide Boilers in oil refineries are compiling outstanding records. The twelve units already on stream have produced, since 1953, savings of millions of dollars in fuel costs. And every day they are in operation, they continue to save money. Each of these boilers is quickly paying for itself. No wonder a total of 18 units has been ordered to date.

**Big fuel savings** are achieved because B&W "CO" Boilers put sensible and combustible heat to work. In extended, sustained service they have proved their efficiency, reliability, and economy.

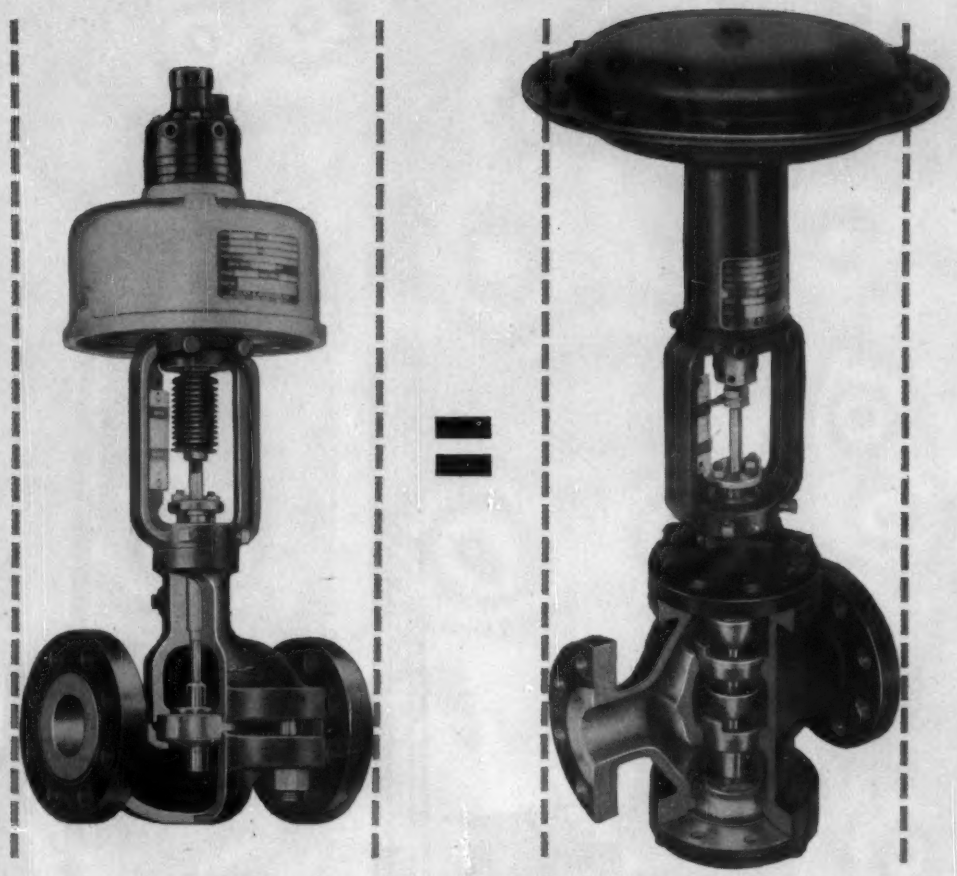
**The cracking unit** becomes independent of other steam sources. The boiler can be operated at all times, whether or not the cracking unit is on stream.

**B&W engineers,** experienced in meeting differing refinery conditions, can design a B&W "CO" Boiler to fit your specific requirements, for any steam pressure and temperature, for any size cracking unit. Write for Bulletin G-87. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-891-CO

BABCOCK & WILCOX

BOILER DIVISION



# "FIT" Companions

## reduce costs . . . increase valving flexibility

With face-to-face dimensions to I.S.A. standards, K&M split body valves are interchangeable with K&M regular globe-body diaphragm valves (and with all standard makes of diaphragm valves).

This *exclusive* feature of the K&M split body design enables you to make significant reduction in your plant inventory investment of replacement valves. It gives you highly desirable flexibility.

Additional flexibility is provided in the K&M split body valve itself. Interchangeable, unitized construction makes it possible to develop 432 different valve combinations from a single split body.

In a matter of minutes you can make the body reverse or direct-acting; switch the operator to dome, diaphragm, or handwheel; change the seat ring to one of several types; recharacterize by selecting a different plug; substitute the replaceable, rotatable flanges; convert from globe to angle type.

The K&M split body valve fits your existing piping and fits your budget.

One more plus . . . K&M split body valves have the largest $C_V$ offered in split body construction . . . more flow for your money.

Write for Catalog 132 completely describing the valve that brings the split body idea to its fullest development.

K&M

diaphragm control valves

Our 79th Year

KIELEY & MUELLER, INCORPORATED

*Oldest Pressure and Level Control Valve Manufacturer*

64 Genung Street, Middletown, New York

S.A. 1697



For more data on advertised products, use Readers' Service Cards, last page.

customer reports prove

# Big Savings with . . .

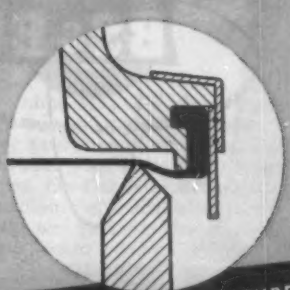
## OCECO V-130 Conservation Regulators

**Exclusive construction assures tight leak-proof closure fully up to operating setting — quick opening — and extremely high flows even at low pressures.**

Oceco V-130 Conservation Regulators provide **greater flow capacity**, size for size, and pressure for pressure, **specially at low pressures** than **ever available before.** Our exclusive construction prevents vapors from escaping at less than set operating pressures. Positive flexing action of the membrane, held under tension, peels off and breaks away any icy formations, preventing freeze-ups. These valves bring never before secured **all weather** economy and dependability to the conservation of volatile products stored in cone, round, flat, lifter or expansion roof tanks. **Write for Bulletin No. 522. It gives full details!**

**PRESSURE BALANCED CONSTRUCTION.**

Tank pressures exerted on both sides of the pliable heat and cold resistant membrane keep membrane always under tension; —assuring tight seating fully up to operating setting— and positive flexing action that peels away icy formations preventing freeze-ups.



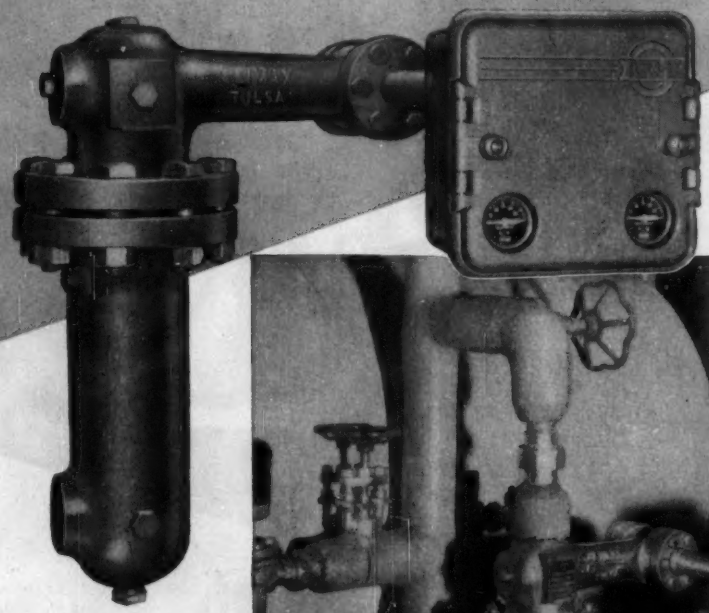
EXCLUSIVE OCECO FEATURE SAVES YOUR VAPOR DOLLARS!

**THE JOHNSTON & JENNINGS CO.**

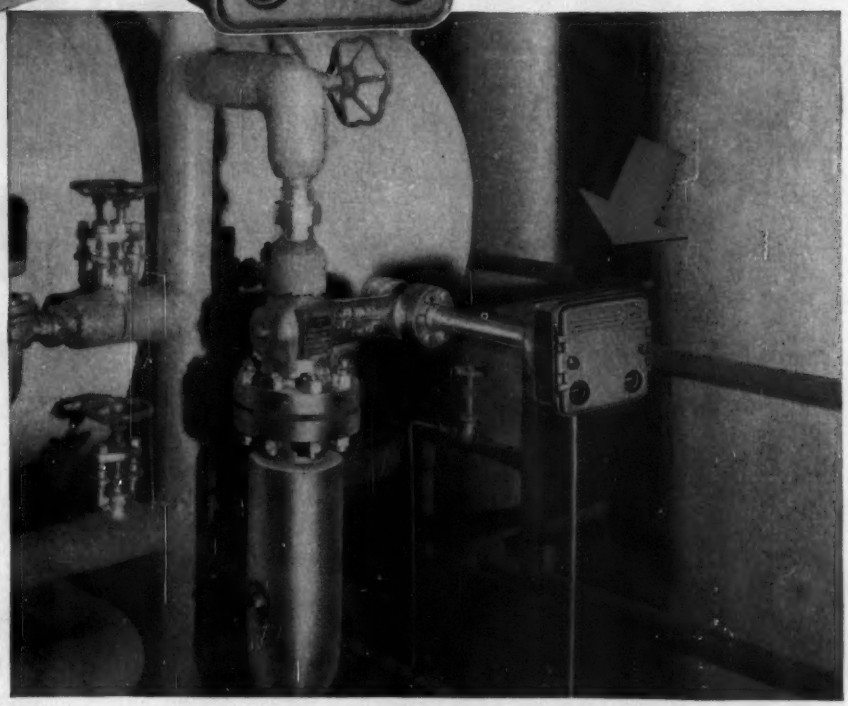
**4700 West Division Street • Chicago 51, Illinois**

***Division of* PETTIBONE MULLIKEN CORPORATION**

# When An External Cage Type Liquid Level Controller Is Indicated, Specify The . . .



## BS&B Type 71-06, Series 2!



OVER 60 YEARS
BS&B
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

1. **"Built In" Accuracy:** Engineered to control within close level tolerances.
2. **Rugged:** Capable of continuous operation under severe service conditions.
3. **Versatile:** May be either transmitter or controller. Set for differential-gap, on-off, or proportional control. Controller output range in 3-15, 3-27 and 6-30 psig.
4. **Time Proven:** Utilized on heat exchangers, reboilers, deaerators, condenser hotwells and other similar applications in plants the world over.

For Complete Information On The BS&B Type 71-06, Series 2, Or Other BS&B Liquid Level Controllers, Contact Your BS&B Sales Engineer — or Write To . . .

**BLACK, SIVALLS & BRYSON, INC.**
Controls Division, Dept. 4-F4
7500 East 12th Street
Kansas City 26, Missouri

*News and Notes on...*

# Good Packing Practice

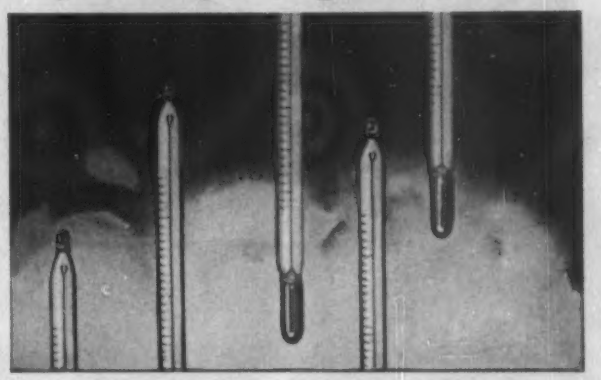
JOHNS-MANVILLE JM PRODUCTS

**Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.**

## *Subject of the month:* High Operating Temperatures

### *Question:*

***What sealing materials are currently available that will match conditions brought about by higher and higher operating temperatures?***



### *Condition 1*

**FOR LASTING VALVE SEALS AGAINST SUPERHEATED STEAM AND DRY GASES**

Designed to meet today's demand for a packing that will maintain a tight seal against steam and dry gases on valves working at line temperatures up to 1200F, J-M High-Temperature Valve Stem Packing, Style 397, offers the three-way protection of a heat-resistant plastic core, asbestos yarn, and Inconel wire reinforcement. For lasting protection of valve stems during storage, this efficient packing is now available with J-M No. 9 corrosion inhibitor.

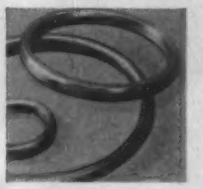
### *Condition 2*

**FOR UTILITY SEALING IN GENERAL APPLICATIONS REQUIRING HEAT AND FLAME RESISTANCE**

Wherever your operation calls for a utility gasketing material that withstands both heat and flame, specify J-M Asbestos Rope, Style 4200. Made of 99% pure asbestos, this material can take temperatures far in excess of other grades of rope. You'll find it a handy, reliable gasket for sealing joints between furnace doors and brickwork, boiler expansion joints, blast furnace connections, ingot moulds, and countless other uses. Ask for information about J-M Style 4200 Asbestos Rope.

### *Condition 3*

**FOR FLANGES WORKING AT TEMPERATURES TO 1600F AND HIGHER**



Elevated temperatures are efficiently sealed using J-M Goetze V-Tite Gaskets. Used in flanges grooved for ring joint gaskets. Materials are available for service ranging upwards of 1600F. Controlled hardening assures correct flow of material at low bolt stress. Temperature range —320F to +1600F and higher.

### *Condition 4*

**FOR PACKING PROBLEMS IN ANY TEMPERATURE RANGE**

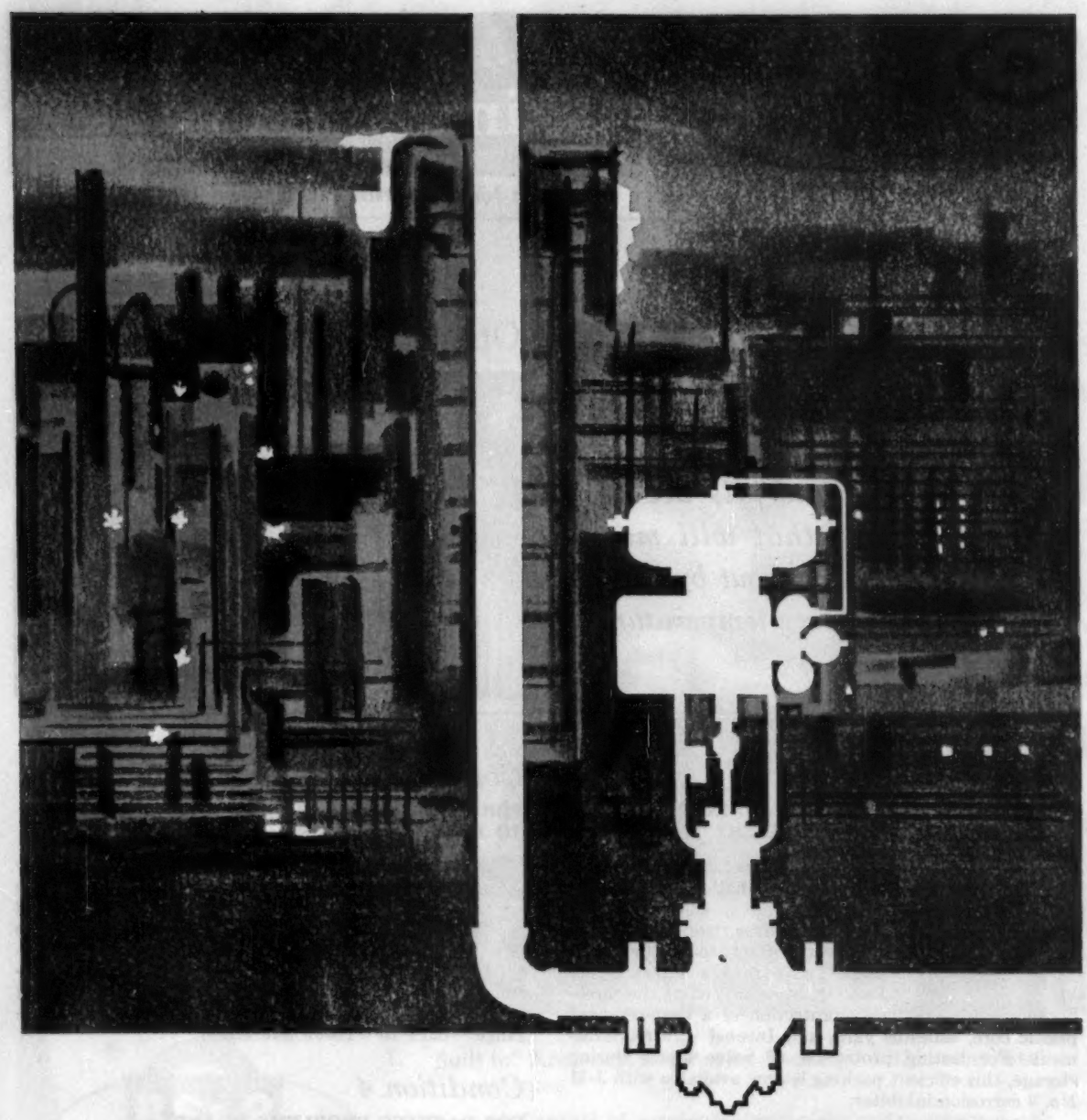
Your Johns-Manville field representative is a trained specialist in packing problems of all types. He's located near you, to help out whenever you need specialized packing information. For information on new packings and gaskets—for engineering and design advice—for tips on more efficient, more economical packing techniques—your Johns-Manville representative is a good man to know.

For information on any Johns-Manville Packings and Gaskets, write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

**JOHNS-MANVILLE**



For more data on advertised products, use Readers' Service Cards, last page.



# ...almost forgotten...because it does its job so well!

Dependable, year-after-year performance makes a Fisher Diaphragm Motor Valve the preferred control in the power and process industries. The Fisher D.M.V. has features not available on other brands. The extra thick steel casing, the precision finished valve stem, the large capacity and the trouble-free operation —these are just a few of the reasons a Fisher gets the nod when it comes to diaphragm motor valve selection.

If you want to know more about the ultimate in control—the Fisher Diaphragm Motor Valve —write for Bulletin E657A.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

**FISHER GOVERNOR COMPANY**

Marshalltown, Iowa / Woodstock, Ontario / London, England

FISHER® Controls

SINCE 1880



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# 9 forms to fit your needs in

# SOLVAY CAUSTIC SODA

## . . . and all include Solvay extra services

To help you use SOLVAY Caustic Soda most *efficiently*, we make 9 forms. To supply it *rapidly* and *dependably*, we produce it in 5 widely-scattered plants. To aid you in applying it most *effectively*, we provide technical service and literature based on extensive field work with users and painstaking laboratory research.

SOLVAY®

Sodium Nitrite • Potassium Carbonate • Chlorine
Caustic Soda • Calcium Chloride • Caustic Potash
Sodium Bicarbonate • Ammonium Chloride • Vinyl
Chloride • Chloroform • Methylene Chloride • Methyl
Chloride • Para-dichlorobenzene • Cleaning Compounds
Hydrogen Peroxide • Aluminum Chloride • Ammonium Bicarbonate • Soda
Ash • Carbon Tetrachloride • Monochlorobenzene • Ortho-dichlorobenzene
Mutual Chromium Chemicals • Snowflake® Crystals

***SOLVAY dealers and branch offices are located in major centers from coast to coast.***

**SOLVAY PROCESS DIVISION**
ALLIED CHEMICAL & DYE CORPORATION
61 Broadway, New York 6, N. Y.

BF-4

Please send without cost SOLVAY Caustic Soda sample or samples and literature as follows:

☐ 76% powdered ☐ 76% solid ☐ 76% ground ☐ 76% flake
☐ 76% small flake ☐ 50% liquor ☐ 73% liquor ☐ 50% mercury cell liquor ☐ 73% mercury cell liquor
☐ Technical Bulletin No. 6, "Caustic Soda"
☐ Wall chart of handling precautions

Name_____

Position_____

Company_____

Phone_____

Address_____

City_____ Zone_____ State_____



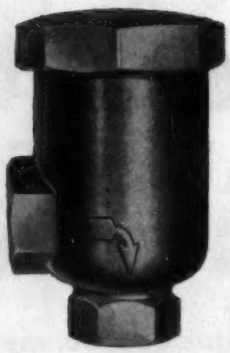
For more data on advertised products, use Readers' Service Cards, last page.

# need

# steam traps?

*name the way you want them!*

TYPE A



TYPE D

TYPE C

Nicholson can supply your steam traps, exactly as you want them . . . for any service, any condition. Name the size, material, pressure, capacity you need. Types A, D, C are the ones you'll most likely use. Make your selection.

**Sizes:** A—from ¼" to 1". D—from ¼" to ¾". C—from ½" to 2".

**Materials:** Cast Iron, Cast Steel and Bronze.

**Pressures:** A and D—Vacuum to 200 lbs. C—Vacuum to 300 lbs.

**Capacities:** From two to six times greater orifice area and capacity than other traps of comparable size.

Why wonder about your steam traps . . . when you can get Nicholsons exactly as you need them for your own applications. Nicholson traps are simple in design, have only one moving part . . . a valve that discharges condensate and prevents steam loss.

You get faster warmup, with high air-venting capacity. You eliminate costly leakage, with a powerful shut-tight valve action. You get a trap that's service-tested, when you specify Nicholson. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and engineering offices in 98 principal cities.

NICHOLSON

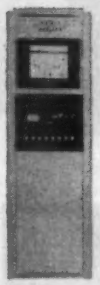
of Wilkes-Barre

**M-S-A (LIRA) Infrared Analyzer (Model 200)**

Low-cost deflection type unit for automatic, continuous, high speed, accurate analysis. Detects one component in a simple or complex mixture of gases or liquids. Unitized construction makes maintenance easy. All controls readily accessible on front panel. Write for details.

**M-S-A Carbon Monoxide Analyzer**

Single or multipoint cabinets designed as alarms or recorders are available for detecting or measuring low concentrations of carbon monoxide in air. Measurements are based upon measurement of heat of oxidation when sample is drawn through granular catalyst. Write for details.

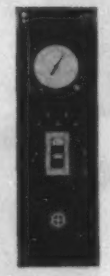


**M-S-A Combustible Gas Analyzer**

Adaptable for use with any gas or vapor of which the explosive range, and molecular weight are known. Applications extend to all industries where combustible fluids are employed. Now available with remote filament heads specifically adapted to high temperature applications. Write for details.

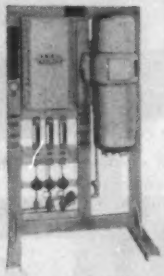
**M-S-A Gas Thermatron**

Simultaneously uses thermal conduction and thermal convection to provide simple, accurate, physical measurement of a single component in a complex mixture of gases without interference from other constituents. Can be used in many gas mixtures. Write for details.



**M-S-A Oxygen Indicator**

For precise, continuous measurement of oxygen content of inert and combustible atmospheres in chemical, metallurgical and petroleum industries. Provides means for improving safety of utility operations and controlling pipeline corrosion. Write for details.



**M-S-A Water Vapor Recorder**

Detects trace moisture in air or gas streams. Operation is based on measurement of the heat energy exchanged when a gas is adsorbed on or desorbed from the surface of a solid adsorbent. Can be calibrated for various ranges from 0 to 10 parts per million up to several percent. Write for details.

# This line-up of M-S-A® Gas Analyzers can help solve your process stream problems

M-S-A Gas Analyzers have earned a sound reputation for on-stream accuracy and dependability while solving a myriad of complex control problems. Chances are, some of the problems confronting you now have already been solved for others, with one of the basic units described above.

The experience and service we can bring into play may provide the breakthrough you're looking for in successful process stream control. Our thirty years in the business of gas analysis instrumentation are worthy of your consideration. Get in touch with an MSA Instrument Specialist for details, or write for helpful literature.

MSA

**INSTRUMENT DIVISION**

**MINE SAFETY APPLIANCES COMPANY**

Pittsburgh 8, Pennsylvania

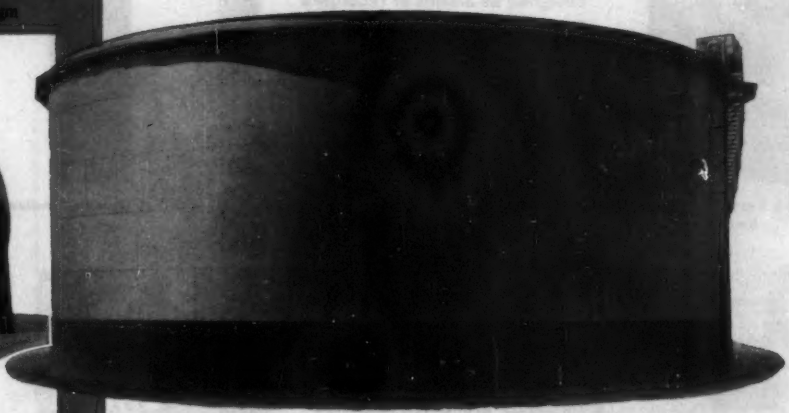
*At your service: 76 Branch Offices in the United States*

# HAMMOND

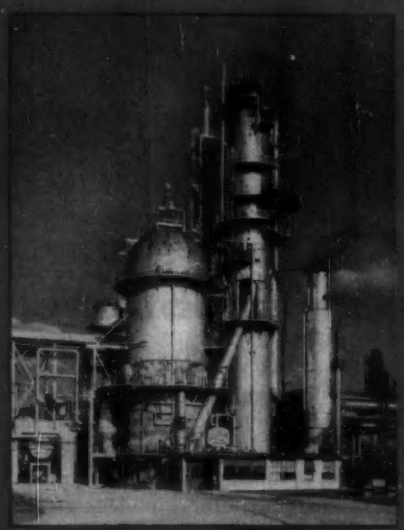
## STORAGE TANKS and PLATE FABRICATION

HAMLIFT* tank with vapor-saver diaphragm

Hammond Sphere

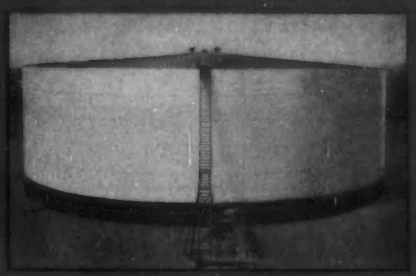


Hammond **TUBESEAL*** and **SPRINGTITE*** Floating Roof Tanks



Process Vessels—Steel • Stainless • Alloys • Cladmetals

Water Storage Tanks



Cone Roof Tanks

*The universal acceptance of Hammond-built equipment is the result of more than half a century of experience in the design, fabrication and erection of storage tanks, process vessels and steel plate construction for the petroleum, chemical and allied industries, and for water supply.*

## HAMMOND IRON WORKS

WARREN and BRISTOL, PA. • PROVO, UTAH • CASPER, WYO. • BIRMINGHAM, ALA.

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CHICAGO 3, ILL. • ARLINGTON, VA. • GREENVILLE, S. C. • LOS ANGELES 57, CALIF. • MEXICO CITY
"TIPSA," BUENOS AIRES • PORT-AU-PRINCE, HAITI • LIMA, PERU

*Licensees:* CALIFORNIA, CANADA, ENGLAND, BELGIUM, GERMANY, ITALY, FRANCE, AUSTRALIA, JAPAN, THE NETHERLANDS, COLOMBIA, BRAZIL

Patented

HAMONDTANK

**HERE ARE THE TEST PHOTOS:**

This is a Rockwood Spot Protection System discharging FogFOAM at a pipeline pumping station. Fire could break a link in the pumping system which could interrupt or stop refinery production. The Rockwood System goes off automatically by a rate-of-rise detection system and protects against such an eventuality.

Here's the same scene from another angle after only 3 minutes of the Rockwood Protection System operation! There's a four inch blanket of Rockwood FogFOAM on the floor — and there's no longer any danger of flashfires starting.

# Rockwood FOAM delivers four inches of fire protection *in three minutes!*

Rockwood FogFOAM systems *instantly and automatically* discharge FogFOAM to the fire area where it forms a fast flowing heavy blanket of FOAM. Within seconds of the fire's start Rockwood FOAM literally covers the fire and strangles it. Flashbacks are prevented.

Write for full information on how your plant can be spot protected against costly flammable liquid fires by Rockwood precision engineered fire-fighting equipment. Send for your booklet now —

**ROCKWOOD SPRINKLER COMPANY**

*Engineers Water . . . to Cut Fire Losses*

*Distributors in all principal industrial areas*

**ROCKWOOD SPRINKLER COMPANY**
2091 Harlow Street
Worcester 5, Mass.

Please send me your illustrated booklet on Spot Protection Systems.

*Name*.....

*Title*.....

*Company*.....

*Street*.....

*City*.....*Zone*....*State*.....



For more data on advertised products, use Readers' Service Cards, last page.

*our research is your reward*

# Split-Second Response ... ±1°F Control in Catalytic Reforming at Imperial Oil Ltd.

## ...with Selas Gradiation® Heating

Rapid, precise heating is of utmost importance in this critical petroleum process. Where a 5°F variation in outlet temperature can adversely affect product octane by as much as one number, the value of Gradiation heating—providing ±1°F control—is obvious.

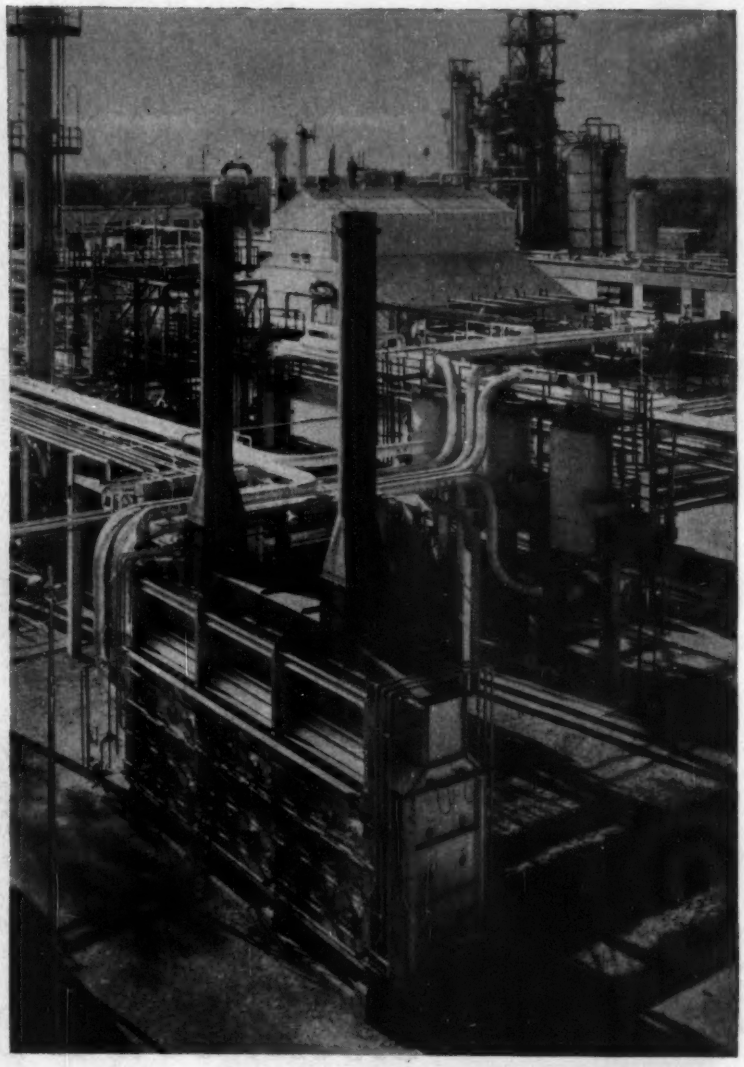
Selas Gradiation heaters are in service in most of the major catalytic reforming processes: in visbreaking, light hydrocarbon pyrolysis, in high temperature heating including cylindrical reactors.

In critical processing operations in the petroleum and petrochemical industries, Selas Gradiation heating provides:

- Preciseness of heating.
- Ability to handle a variety of feed stocks; for example: ethane, propane, ethane-propane mixtures including propylene—in one heater.
- Instant response to controller demand, achieving close equilibrium approach.
- Zone Control . . . up to 3 independent coils in the same heater.

Specially-engineered and custom-built to meet your specific processing needs, Gradiation tubular heaters are available both Selas-shop-assembled and field-erected. Selas also builds Econotherm* heaters for non-critical processing where low first cost is an important factor.

Send for Bulletin 74 "Gradiation Heating for Petroleum and Chemical Processing." Selas engineers will be glad to discuss your heat-processing requirements with you.



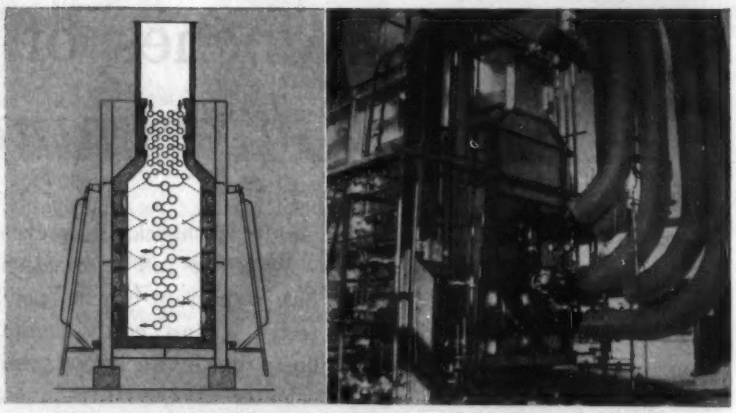


Diagram illustrates the flow of material through the multiple coils during preheat, first and second reheat cycles.

* Trade Name

*Gradiation is a registered trade name of Selas Corporation of America.*

**SELAS**
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

*Heat and Fluid Processing Engineers*
DEVELOPMENT • DESIGN • CONSTRUCTION

# where trouble-free performance is a matter of pride...

NEW ENGLAND ELECTRIC | SALEM HARBOR STATION

this condenser is tubed with...

SCOVILL

## HEAT EXCHANGER TUBE

One of the Northeast's most modern and efficient steam power plants, Salem Harbor is being expanded to deliver 300,000 kw to New England's homes and industries.

Scovill Aluminum Brass Heat Exchanger Tube has been specified for installation in condensers serving Salem Harbor's 80,000 kw reheat-type turbo-generators . . . where trouble-free operation is essential in maintaining high efficiency.

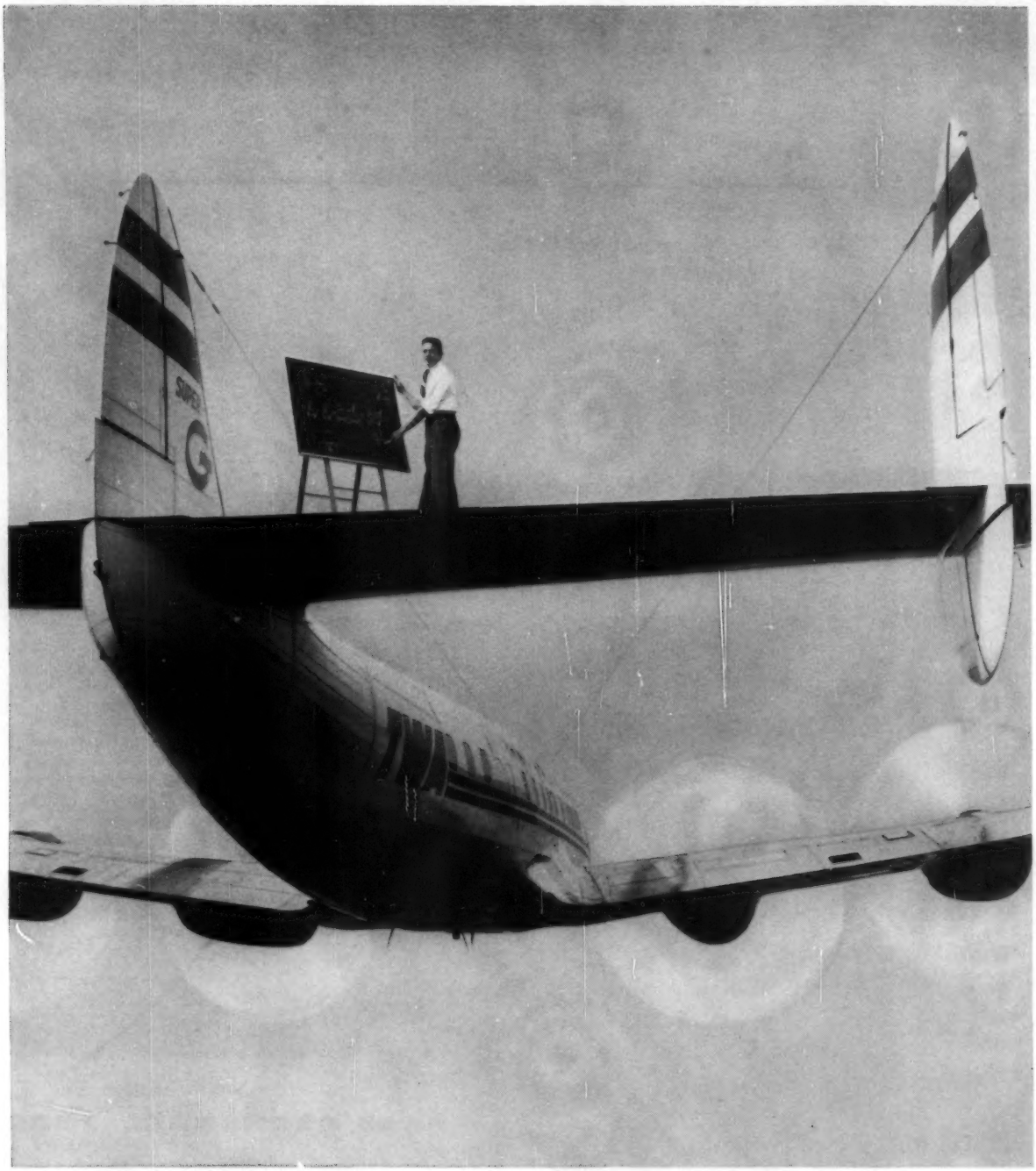
Let Scovill Technical Service and Scovill Heat Exchanger Tube help you, also, to achieve trouble-free performance.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

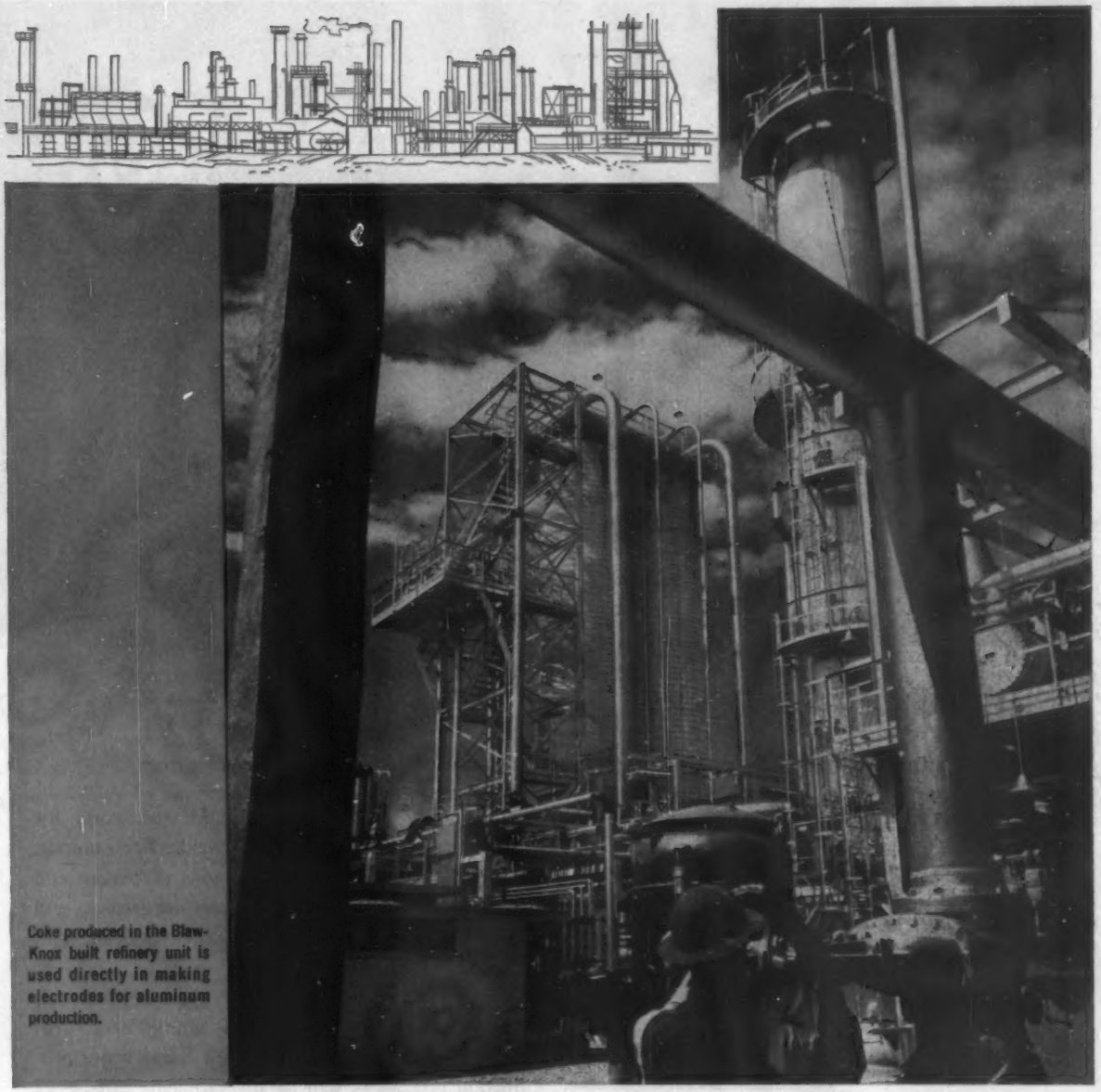
Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone Plaza 4-1171.

**HEAT EXCHANGER TUBE** For Applications from Marine to Petrochemical, From Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

28C38



**Oilmen should be up in the air.** An oil company physicist and his slate of equations may seem out of place in the sky. But airmen couldn't get off the ground without oilmen. Oil helped fly more than 50 million passengers on U. S. air lines last year. Oil research helps new jet passenger planes span the country in less than four hours. Remember these things when you hear misinformed people talk against your industry. Speak up then and there—tell how you help give America wings! **SHELL OIL COMPANY**



Coke produced in the Blaw-Knox built refinery unit is used directly in making electrodes for aluminum production.

# PETROCHEMICALS

## are a growing factor in two great industries ... petroleum and chemicals

Wide experience, gained through long association with diversified problems in both petroleum and chemicals, as well as in petrochemicals, enables Blaw-Knox engineers to meet your most exacting requirements in designing, engineering and building plants in all three process areas. When planning new or expanded facilities, investigate how this specialized background can serve you, too.

BLAW-KNOX

**BLAW-KNOX COMPANY**

*Chemical Plants Division • Pittsburgh 22, Pa. • Chicago 1, Ill.*

*Birmingham • New York • Haddon Heights, N.J. • San Francisco • Washington, D.C.*



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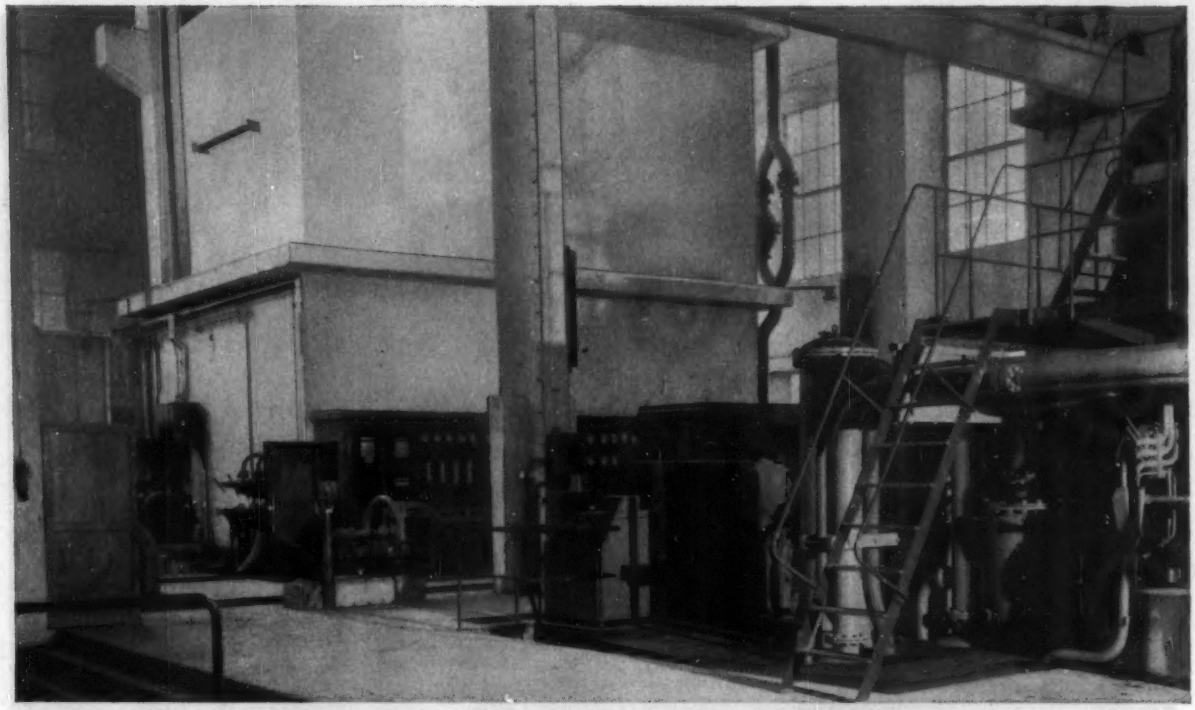


# CONTROLLING ATOMS FOR INDUSTRY

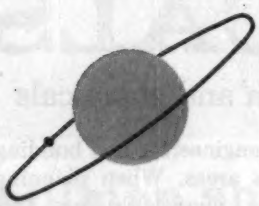
## ...with smaller, more efficient piles using heavy water as a moderator

HEAVY WATER, in demand as a highly efficient and economical moderator of neutron activity in atomic reactors, is now being produced by low-temperature liquefaction and fractional distillation in a plant designed and built in France by Air Liquide — *the only heavy water plant of this kind in the world.*

The development of the heavy water plant is a logical extension of the liquefaction methods and techniques perfected by AIR LIQUIDE over the past half century and used throughout the world for numerous applications in many fields. For example, in North America alone, 2000 tons of oxygen and 2000 tons of ammonia synthesis mixture are delivered every day by AIR LIQUIDE units, designed and built in North America.

American Air Liquide will be pleased to consult with representatives of industries, utilities or government agencies concerning this new heavy water production process as well as any problems capable of solution by the application of our liquefaction and fractional distillation techniques.

**Enquiries should be addressed to American Air Liquide Inc., Chrysler Building, 405 Lexington Avenue, New York 17, N.Y. Telephone: YUkon 6-6544.**



THE PROBLEMS which have been solved by Air Liquide, and which have gradually led to temperatures as low as 20° K necessary for heavy water production are:

- **Air separation**
- **Rare gases recovery**
- **Coke oven gas separation**
- **Refinery gas separation**
- **$CO_2$ purification**
- **Methane purification**
- **Natural gas liquefaction**
- **Pure CO production**
- **Liquid nitrogen tonnage plants**
- **Helium recovery and purification**
- **Hydrogen liquefaction**

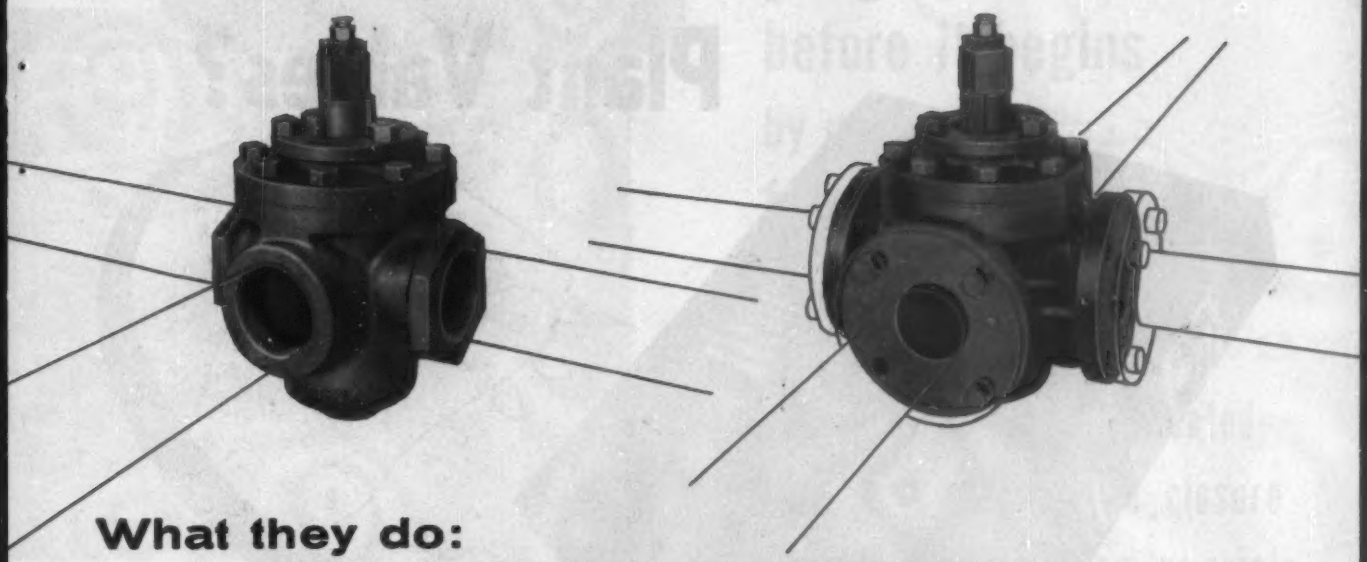
**AMERICAN**
**AIR LIQUIDE**
**ENGINEERING & CONSTRUCTION DIVISION**

OLDEST IN EXPERIENCE — NEWEST IN DESIGN

**405 LEXINGTON AVE., NEW YORK 17, N.Y.**

*In Canada:* L'AIR LIQUIDE, 1111 Beaver Hall Hill, Montreal, Que.

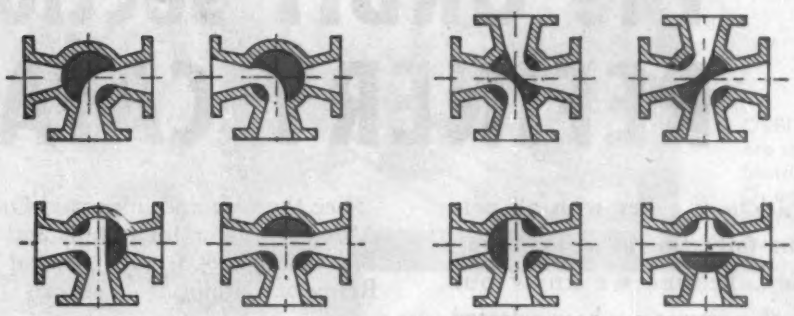
# WHERE WOULD YOU USE THESE VALVES?



## What they do:

*One* Rockwell-Nordstrom Multiport valve can do the job of *three* or *four* ordinary valves! By simply moving the lubricated plug through 90°, flow through the valve "ports" is stopped, or diverted. This means that piping is greatly simplified and the saving in valves is obvious. Rockwell-Nordstrom Multiport valves cost less to use, too, because the lubricant that assures positive shut-off also eliminates metal-to-metal wearing friction.

For just a few of the literally hundreds of stop and port arrangements, see the drawing below. How could you use these valves in *your* flow control system?



## Here are a few uses:

Rockwell-Nordstrom Multiport valves are used in the process industries for batching, blending and product flow control . . . they're used in refineries for product lines and pressure relief on vessels . . . they're used in many industries where flow must be stopped, changed or relieved. To get more information on where and how Rockwell-Nordstrom Multiport valves will save you money, send the coupon below.

ROCKWELL-Nordstrom VALVES

it's **ROCKWELL**

MANUFACTURING COMPANY

**Rockwell Manufacturing Co.**
**Pittsburgh 8, Pennsylvania**

☐ Please send bulletin V-203
☐ Please have your sales engineer call

Name_____ Title_____

Address_____

City_____ Zone____, State_____

# *Writing Specs on*
# Plant Valves?

*You'll save time by using the industry's most complete source of equipment-service information.*

## *...get them FAST in*
# The ORBIT section of REFINERY CATALOG

Writing specifications is easier with all pertinent data at your fingertips in a single, authoritative reference. Because we know our customers prefer such a source, we have selected the REFINERY CATALOG to carry specifications of our products to over 6,000 U. S. buyers and specifiers as well as to more than 2,000 key buying locations abroad. Carefully controlled distribution of this Catalog has made it available to you.

See the new and improved Orbit forged steel ASA class valve for liquids and gases on Pages 770 through 803, 25th Annual Edition of the Refinery Catalog.

The new and improved Orbit ASA class valve is equal to a stainless trimmed valve in quality—yet it is priced to compete with other makes of carbon trimmed valves.

For complete details on the new and improved Orbit ASA class valve, see the 25th Annual Edition of the Refinery Catalog, or write for Catalog 58-B.

**ORBIT VALVE COMPANY**
P. O. BOX 699 TULSA, OKLAHOMA
Phone LUther 4-4761 TWX TU 925

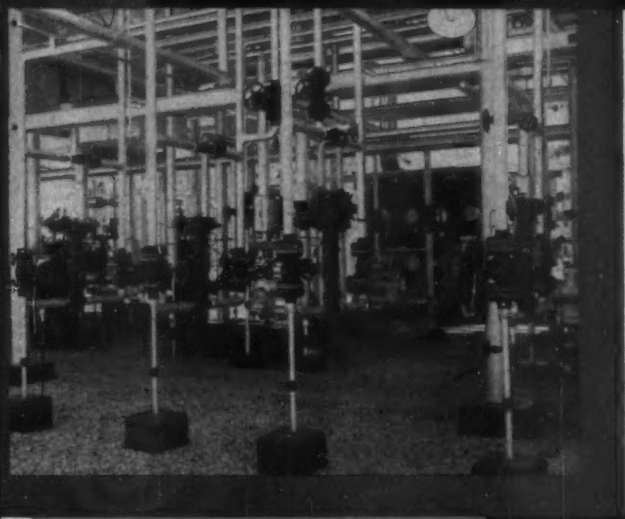
ORBIT VALVES ®

# stop

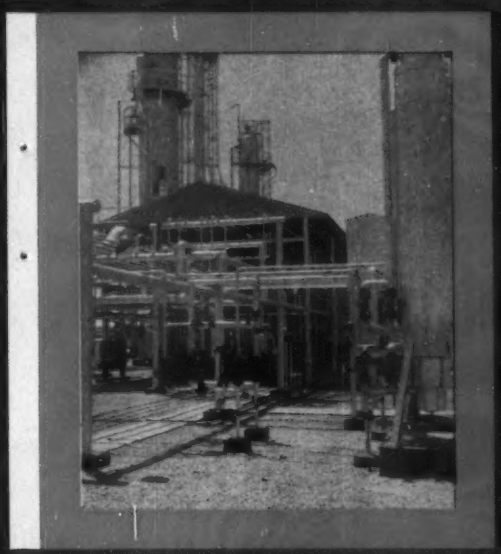
## product contamination before it begins

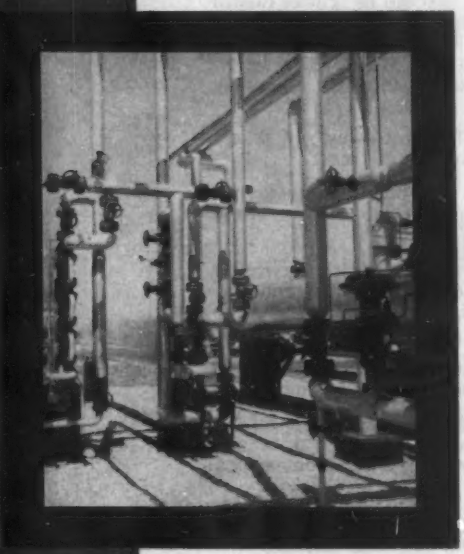
## by using orbit forged steel asa class valves

## because with orbit's non-lubricated positive closure seating principle ...costly re-runs are eliminated



LEFT
AT A KANSAS GASOLINE PLANT:
In foreground, depropanizer and debutanizer, reflux accumulator pressure relief and level control valves. Reflux pumps in background.

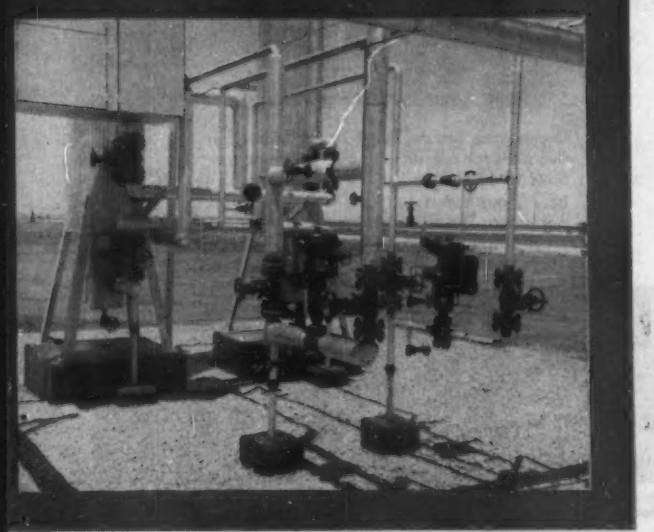




ABOVE
Left to right, de-ethanizer feed, bottoms exchanger, and liquid level control valve.

LEFT ABOVE
Propane dehydrators in right foreground. In background, plant-process pump area.

LEFT
Propane dehydrators



ORBIT ASA CLASS VALVES are available in Carbon or Stainless Trim. Full Round Opening Sizes 1" thru 4". Ratings: 300 lbs. thru 2500 lbs. Flanged or Screw Ends. Venturi Opening Sizes 2" thru 6". Ratings: 150 lbs. thru 2500 lbs. Flanged End Only.

Available thru your favorite oil field supply store or refinery supply house.

ORBIT VALVES®


**ORBIT VALVE COMPANY**
BOX 699, LUther 4-4761, TWX TU 925 TULSA, OKLAHOMA

**WAREHOUSES:** HOUSTON, TEXAS, 407 Velasco, CApitol 8-6623, TWX HO 115; ODESSA, TEXAS, 402 West County Road, FEderal 7-2263, TWX ODESSA TEX 8041; EDMONTON, ALBERTA, CANADA, 7119-104th Street, Phone 391-283

**WEST COAST REPRESENTATIVE:** Fred P. Koenig Company, Long Beach, Calif., 3815 Atlantic Avenue, GArfield 4-3834

**CANADIAN REPRESENTATIVE:** T. R. Pickford & Company, Ltd., Calgary, Alberta, 536 8th Avenue West, Phone 2-7371

**EXPORT REPRESENTATIVE:** New York 36, N. Y., 500 Fifth Avenue, BRyant 9-2236

# new STRONG

## ductile iron steam traps give you cast steel service at less than half the price!*

Strong's new 540 Series Hydro-Flex Steam Traps are made of DUCTILE (NODULAR) Iron that can be bent or twisted without breaking. This newest metallurgical development, adopted by ASME*, enables Strong to produce traps for service up to 500 psi and 650°F with ample safety factor. Ductile Iron economy permits sale of these traps at less than half the price of comparable cast steel traps.

Here are six reasons—besides low cost—why you should specify and use Strong Ductile Iron Steam Traps:

**1. Safer to use** because Ductile Iron body and cover will bend or twist in case of explosion or fire whereas brittle materials might shatter or break.

**2. Especially recommended** for drainage and drip service on high pressure steam systems and on both high and low pressure systems in chemical plants and refineries where steel is normally required.

**3. Wide choice of sizes and capacities:** Pipe sizes from ½" to 2", capacities to 42,800 pounds of water per hour.

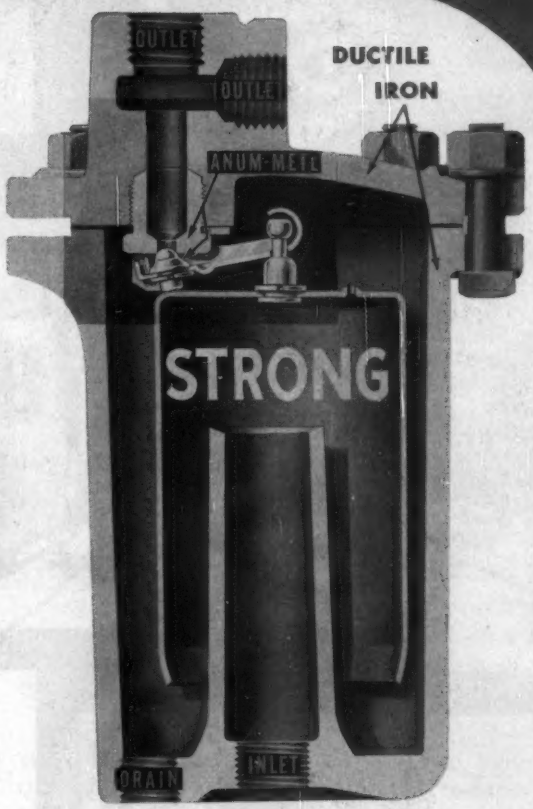
**4. Connections:** Traps with screwed connections regularly furnished. (Although Ductile Iron can be welded or brazed under controlled shop conditions, welding is *not* recommended for field fabrication.)

**5. Features** famous "Hydro-Flex" inverted bucket trap action with only two moving parts for high discharge capacity and unmatched performance on light loads.

**6. All stainless steel** internal parts . . . screwed-in renewable valve and seat of wear resistant ANUM-METL, guaranteed leakproof for one year.

*Ductile (Nodular) Iron meets the requirements of the ASME Code for use in vessels at pressures to 1000 psi and temperatures to 650°F (80% of cast steel service).

Strong 540 Series Ductile Iron Traps are available from your local Strong Distributor. Call him for more information, or contact . . .




Ductile Iron Steam Traps are produced in five sizes for pressures to 500 psi, temperatures to 650°F. Pipe sizes range from ½" to 2", capacities to 42,800 lbs of water per hour. Type "M" Vacuum and Lifting Traps also made of Ductile Iron.

## STRONG, CARLISLE & HAMMOND

1392 WEST 3rd STREET • CLEVELAND 13, OHIO

air traps • strainers • reducing valves • vacuum or pumping traps
continuous blowdown valves • separators • engine stops • F and T traps

# 7,450 ft. of protection from 1000°F chemicals provided by Carpenter Welded Stainless Tubing

• One of the largest ever built, this vertical heat exchanger is used by a leading chemical company as a chemical converter operating at temperatures up to 1000°F. It measures 7½ ft. in diameter by 10 ft. high. The tubes, tube sheets and bonnets are all of Type 321 stainless steel. They convey a highly corrosive chemical catalyst.

The consistent quality and greater uniformity of Carpenter Stainless Tubing are influential factors in its selection for more and more critical applications.

Carpenter delivers these advantages plus the biggest extra of all . . . lower initial cost.

All 40 types of Carpenter Stainless Tubing can deliver these benefits. Contact your local distributor for some solid "how" and "why" information or write for TD 120, Carpenter's newest Selecting and Buying Guide. The Carpenter Steel Company, Alloy Tube Division, Union, N.J.

MEMBER

*Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"*

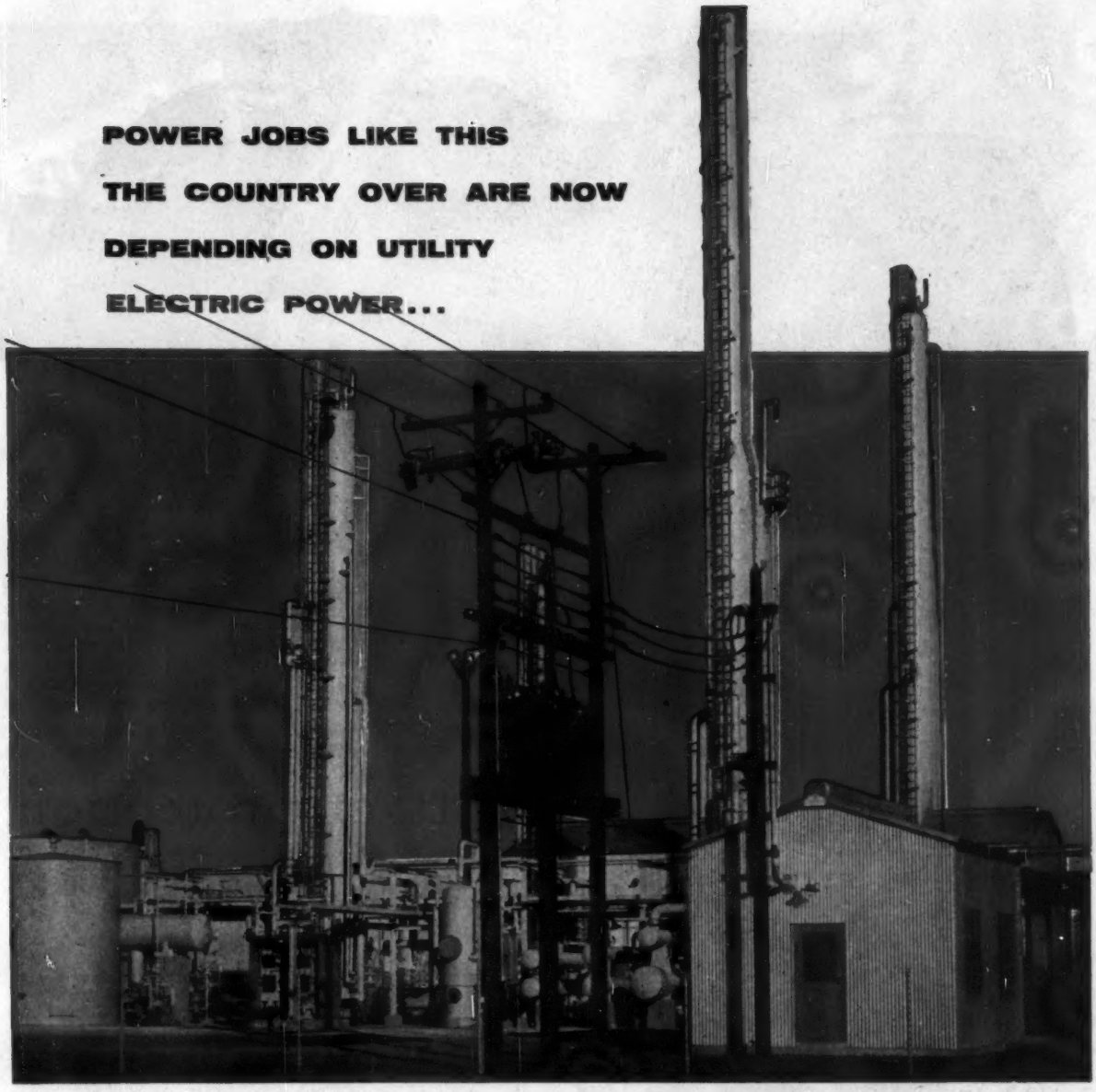
**Carpenter**

**Stainless Tubing & Pipe**



For more data on advertised products, use Readers' Service Cards, last page.

**POWER JOBS LIKE THIS**
**THE COUNTRY OVER ARE NOW**
**DEPENDING ON UTILITY**
**ELECTRIC POWER...**



***Progressive Management is taking a second look***

One of the biggest expansions in refining operations is coming up. If you have any part in this important development don't let your company decide on power until the modern benefits of UTILITY ELECTRIC POWER have been carefully investigated. Call in the sales engineer of your Electric Service Company while your plant is in the planning stage. Convincing facts and helpful counsel are yours for the asking.

Be modern . . . Be progressive . . .
Use UTILITY ELECTRIC POWER.

**PETROLEUM ELECTRIC POWER ASSOCIATION**

P. O. BOX 35006 DALLAS. TEXAS

**HOW TO SELECT WATER-CONDITIONING EQUIPMENT** (NO. 1 OF A SERIES)

# Aerators, Degasifiers, Deaerators

If you want to remove dissolved gases or iron or taste and odor from large quantities of water, you will probably use aeration or degasification as part of the treatment.

Modern equipment for putting air or gases into water or taking them out is highly specialized, ranging from simple, low cost aerators to complex, highly efficient degasifiers.

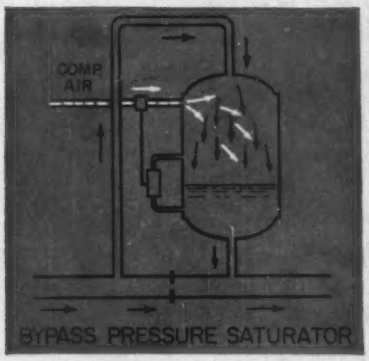
The following descriptions may help you choose the type of equipment that best solves your problem at the lowest cost.

## To introduce air

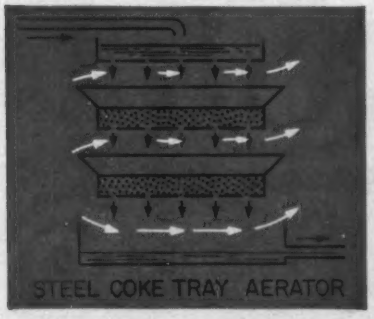
If your problem is simple introduction of air to oxidize iron or manganese, **pressure aeration** may be preferred to avoid repumping. But introducing air into water under pressure can result in supersaturation when the pressure is reduced, causing "milky water" and filter troubles from air binding or upset beds.

A Bypass Pressure Saturator automatically provides aeration without the danger of supersaturation by introducing air to only a predetermined portion of the total flow. (Patented by Permutit.)

If you want to reduce $CO_2$ or taste and odor or accomplish any of these at the same time that you oxidize iron or manganese, an **aerator** is recommended.

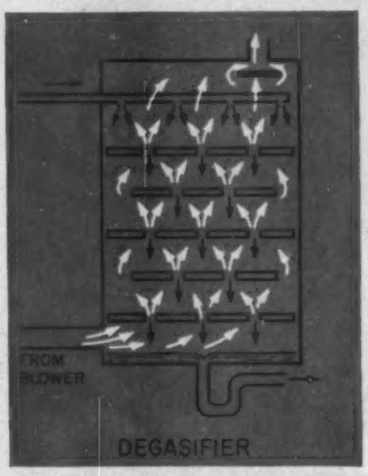



Aerators may be of the open type in which water cascades over trays of graded coke or a series of wood slat trays. Splash aprons reduce splashing, permit free circulation of air. Formation of iron or manganese film on coke surfaces hastens oxidation reactions. Some reduction of $CO_2$ may also take place, raising pH and further helping oxidation.




## To remove dissolved gases

For practically complete removal of $CO_2$, methane, hydrogen sulfide or other gases, the most efficient way is by a **degasifier.**




In a degasifier, water rains down through Raschig rings or wood slat packing countercurrent to a large flow of air from a blower. Thus the freshest air contacts the effluent water, gives lower final gas content. Proper packing design breaks water into thin films, promotes rapid and efficient gas removal.

Degasifiers are totally enclosed, avoiding splashing and spray losses. Outer tank may be of wood, rubber-lined steel, stainless steel or aluminum. Cylindrical units are usually more economical, but square or rectangular shapes may be used. Sizes and capacities are practically unlimited, depending on requirements. Units can be used for water with $CO_2$ as high as 3500 ppm.

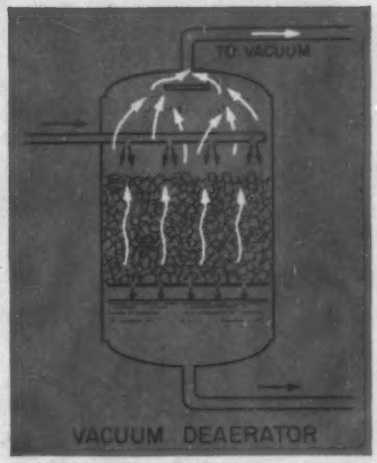
Although degasifiers provide very complete aeration, their higher cost is unwarranted in many cases where simple introduction of air is the main objective.

## To remove oxygen

If you want to remove oxygen without heating the water, use **vacuum deaeration.**

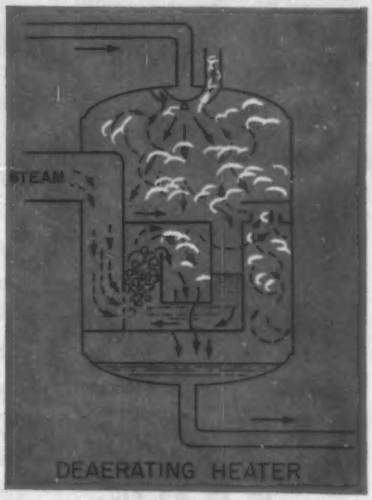
A vacuum deaerator is a steel tank lined where necessary and containing suitable packing such as Raschig rings. A vacuum is maintained in the tank by steam jet ejectors or motor-driven vacuum pumps. Under a vacuum, solubility of gases in water is greatly lowered. As the water trickles down through the packing, the gases present, including oxygen, nitrogen and carbon dioxide, are liberated and drawn off. Type and depth of packing, degree of vacuum, flow rates and other variables must be accurately adapted to your specific conditions for best efficiency.

If the water is to be heated as for feeding boilers, a vacuum is not necessary, and a **deaerating heater** is recommended.




In a spray type deaerating heater, the water is first sprayed through steam which removes most of the non-condensable gases. (The gas-laden steam is condensed and vented.) The water is then reboiled by passing steam through it for final deaeration.

Where less complete removal of oxygen is required, the reboiling (scrubbing) stage may be omitted.

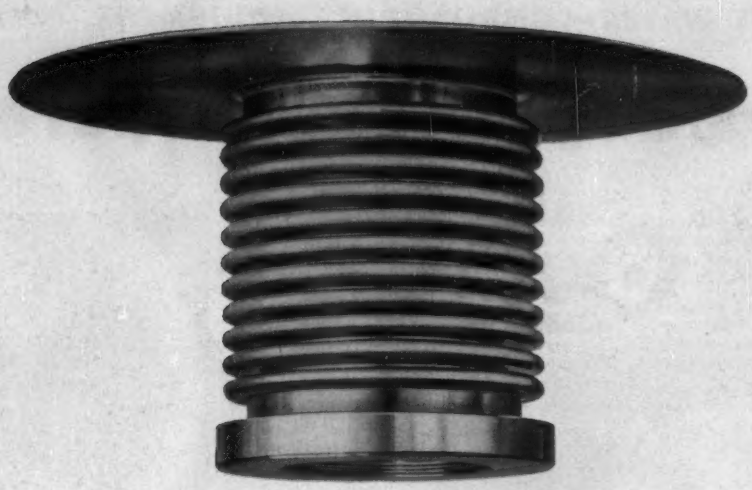



For detailed information on these or any other types of water-conditioning equipment, write: The Permutit Company, Dept. PR-3, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

**PERMUTIT®**
*rhymes with "compute it"*
a division of PFAUDLER PERMUTIT INC.
Water Conditioning
Ion Exchange • Industrial Waste Treatment



For more data on advertised products, use Readers' Service Cards, last page.



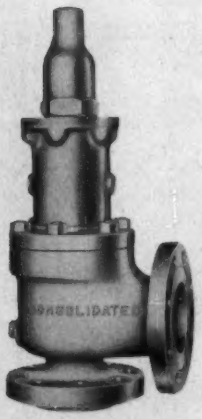
# CORRUGATED SLEEVE

## shields working parts

A durable, two-ply stainless steel Sealing Bellows in Consolidated Safety Relief Valves isolates contaminants, corrosion or viscous fluids from the working parts. The Bellows is balanced with the seating surface. Capacity is less affected by variable back pressure, so you can use smaller discharge piping and reduce the cost of pressure-relieving systems.

Full-rated relieving capacity is certain at all positions of the single blowdown adjusting ring because a fixed maximum secondary orifice provides full lift at 10% overpressure. Even with superimposed back pressure in the relieving system, valve action is consistently positive.

Protection of working parts is but one of many reasons why Bellows Type Consolidated Safety Relief Valves assure absolute protection for personnel and facilities. Write for details, including facts about the Standard valve that you can convert to the Bellows type in your own shop. Ask for Catalog 1900.



Consolidated Safety Relief Valve with Sealing Bellows. Type 1900-30 Series, Sizes: 1½" x 2" to 8" x 10".

MAXWELL & MOORE INC. MANNING M&M TRADE MARK

TI-58R

***CONSOLIDATED SAFETY RELIEF VALVES***

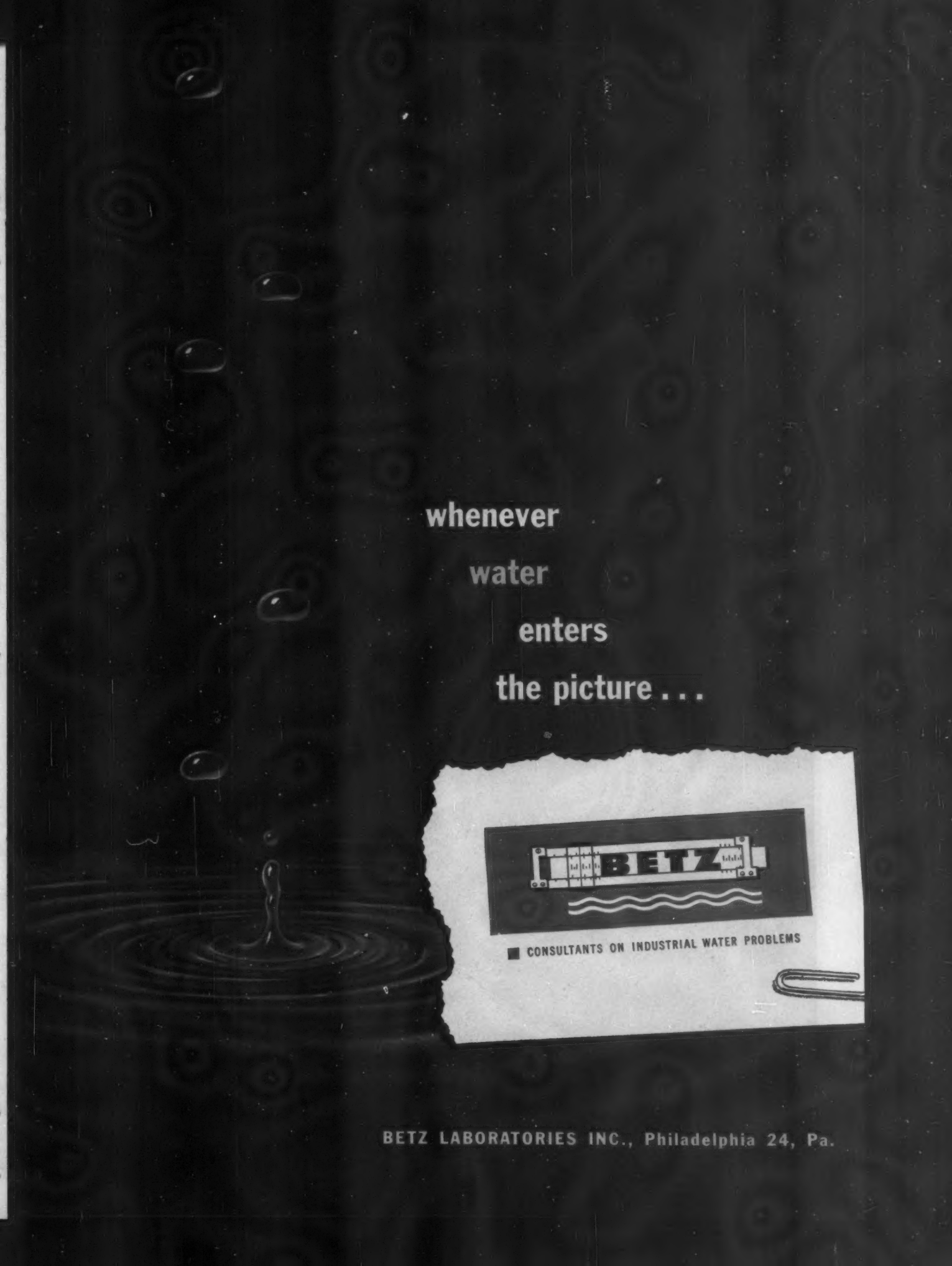
***A product of***

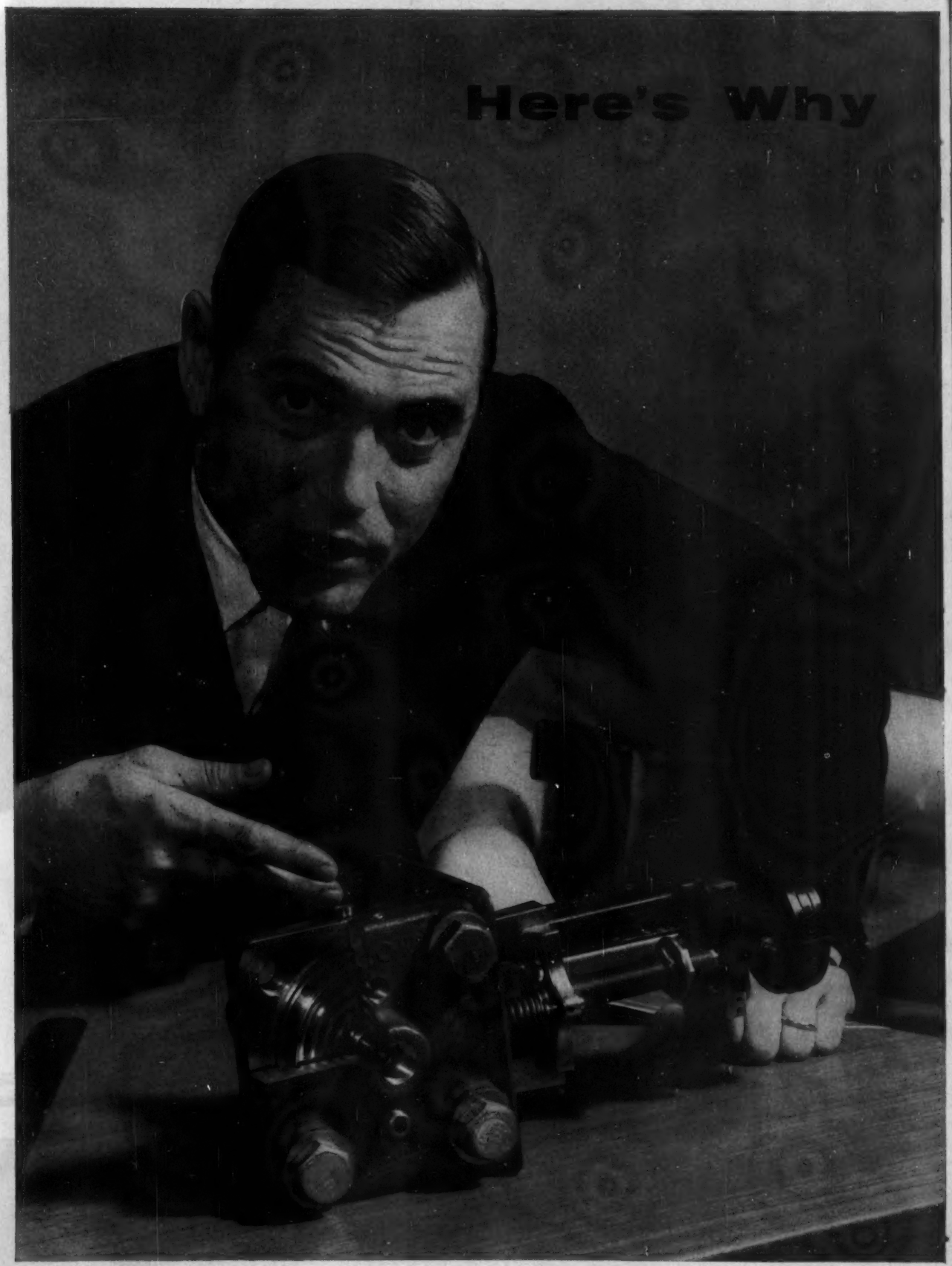
**MANNING, MAXWELL & MOORE, INC.**

*Consolidated Ashcroft Hancock Division • Tulsa, Oklahoma*
*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



For more data on advertised products, use Readers' Service Cards, last page.


whenever
water
enters
the picture . . .
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.


Here's Why

# Masoneilan Model 4811 D. P. Transmitters

## *Give You Top Performance*

These essential features of the Masoneilan design assure optimum performance in differential pressure, flow or liquid level applications . . .

- **Accuracy** within 1% of range span, plus fast response, and minimum hysteresis and nonlinearity. There is no distortion due to outside forces acting on cover and damping is built in at measurement source. Static pressure effect is less than 0.2% per 100 psi change.
- **Rugged Construction** provides complete protection due to overload, negative differential or overranging. Rigid mounting for horizontal or vertical surfaces. All working parts exposed to process fluid are made of Type 316 stainless steel. Extra heavy beam avoids bending.
- **Versatility** — range adjustable between 20 and 200 inches of water; suppression up to 50 inches. Suitable for differential pressure, flow, or liquid level applications.

**Investigate all the advantages** these improved transmitters offer you. Bulletin with full specifications sent on request.

MN7-40

**MASON-NEILAN**

*Division of Worthington Corporation*

**51 NAHATAN STREET, NORWOOD, MASSACHUSETTS**

MASONEILAN

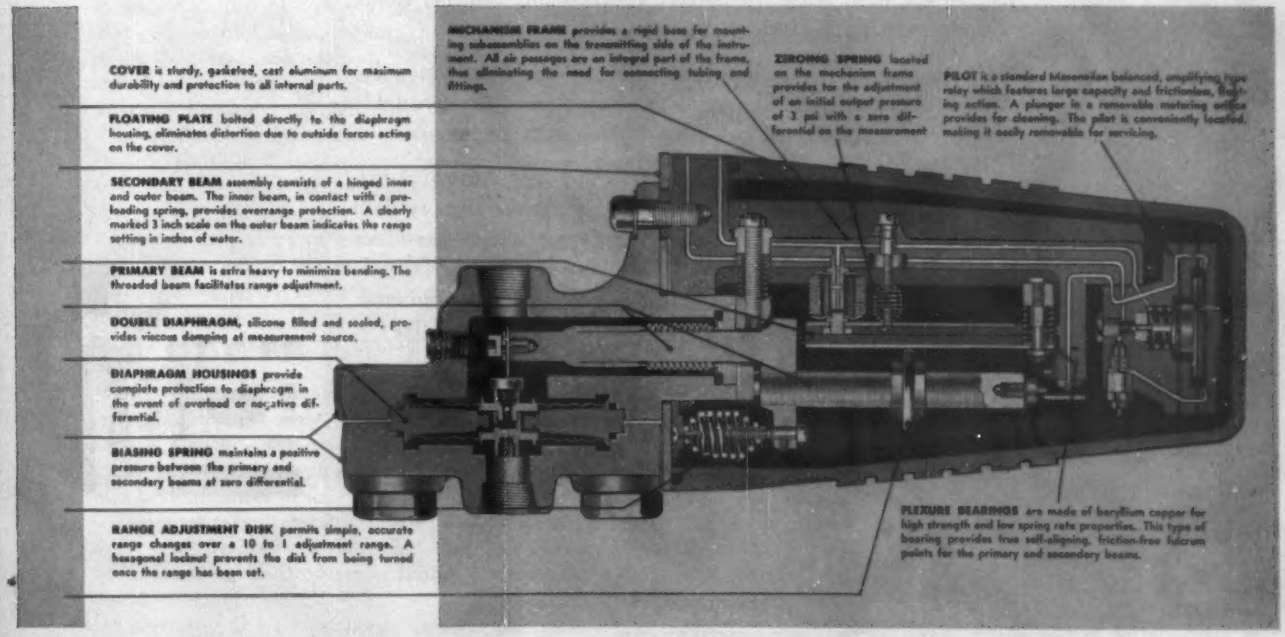
**District Offices or Distributors in Principal U. S. Cities**

**In Canada** — Mason-Neilan Regulator Co., Ltd. — Brantford, Montreal, Toronto

**European Manufacturing Associates**

Crosby Valve & Engineering Co., Ltd., Wembley, Middlesex, England
Worthington, Paris, France
Worthington Gesellschaft M.B.H., Hamburg, Germany
Worthington SIPEC, Milan, Italy

*Distributors in many other overseas countries*


COVER is sturdy, gasketed, cast aluminum for maximum durability and protection to all internal parts.
FLOATING PLATE bolted directly to the diaphragm housing, eliminates distortion due to outside forces acting on the cover.
SECONDARY BEAM assembly consists of a hinged inner and outer beam. The inner beam, in contact with a preloading spring, provides overrange protection. A clearly marked 2 inch scale on the outer beam indicates the range setting in inches of water.
PRIMARY BEAM is extra heavy to minimize bending. The threaded beam facilitates range adjustment.
DOUBLE DIAPHRAGM, silicone filled and sealed, provides viscous damping at measurement source.
DIAPHRAGM HOUSINGS provide complete protection to diaphragm in the event of overload or negative differential.
BIASING SPRING maintains a positive pressure between the primary and secondary beams at zero differential.
RANGE ADJUSTMENT DISK permits simple, accurate range changes over a 10 to 1 adjustment range. A hexagonal locknut prevents the disk from being turned once the range has been set.
MECHANISM FRAME provides a rigid base for mounting subassemblies on the transmitting side of the instrument. All air passages are an integral part of the frame, thus eliminating the need for connecting tubing and fittings.
ZERONG SPRING located on the mechanism frame provides for the adjustment of an initial output pressure of 3 psi with a zero differential on the measurement
PILOT is a standard Masoneilan balanced, amplifying type relay which features large capacity and frictionless, floating action. A plunger in a removable metering orifice provides for cleaning. The pilot is conveniently located, making it easily removable for servicing.
FLEXURE BEARINGS are made of beryllium copper for high strength and low spring rate properties. This type of bearing provides true self-aligning, friction-free fulcrum points for the primary and secondary beams.




For more data on advertised products, use Readers' Service Cards, last page.

AMOCO CHEMICALS—
A NEW RESOURCE

# New to the Amoco Additives line

## V. I. Improver

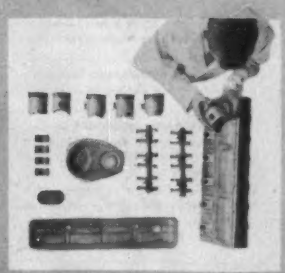
## 3 Metal Deactivator Antioxidants

**V. I. Improver.** Polyisobutylene-type viscosity index improver especially suited for use in multigraded motor oils. Amoco V. I. Improver can help you blend—*economically*—oils that give users: (1) better oil mileage, (2) less octane-requirement increase, (3) better gasoline mileage, (4) easier engine starting in cold weather.

V. I. Improver evaluation data—some of the most extensive in the automotive and petroleum industries—are available to you from Amoco petroleum additive sales engineers.

**3 Metal Deactivator Antioxidants.** Four new Amoco Additives are now available. Their use will eliminate the problem of hydrocarbon oxidation and gum formation in gasolines and other products. The metal deactivator is disalicylal propylenediamine. The antioxidants are: (1) an aminophenol, (2) a phenylenediamine, (3) an alkylated phenol (DBPC).

More information about these new Amoco Additives is available. Amoco sales engineers with special experience in the use of petroleum additives will bring it to you. Your request for data will receive immediate attention.



AMOCO CHEMICALS

AMOCO CHEMICALS CORPORATION

910 South Michigan Ave., Chicago 80, Illinois

# PFAUDLER
## CORROSIONEERING NEWS

*Corrosive chemicals* travel more cheaply in this truck equipped with Pfaudler glassed-steel tanks. Tanks eliminate costly glass carboys which require considerable handling.

# Glassed steel takes to the road to cut freight on acid chloride carting

A certain fatty acid chloride is bought in such quantity by Lever Brothers that glass carboy packaging takes too much time, costs too much in freight and handling, and presents an intolerable breakage problem.

Lever Brothers asked their carrier, Rogers Cartage Company, to talk with us. The result is the glassed-steel tank truck you see above.

Each of the truck's twin tanks will hold 2200 gallons of the acid chloride or any other acidic chemical except hydrofluoric acid. They will also carry most alkalies at moderate temperatures.

Two different chemicals can be carried simultaneously, since each tank is a separate unit with its own manhole, vents, dip pipe, openings, and bottom outlet drain.

The truck travels 297 miles on each of its trips from Monsanto's plant in St. Louis to Lever Brothers in Hammond, Indiana.

The trailer is a conventional unit. We made the tanks and mounted them in such a manner that they will take to any existing road conditions. There is plenty of "give" to the glassed steel; in fact, we've demonstrated that a 36" strip of glassed steel can be flexed six inches in both directions without damage to the glass or its bond.

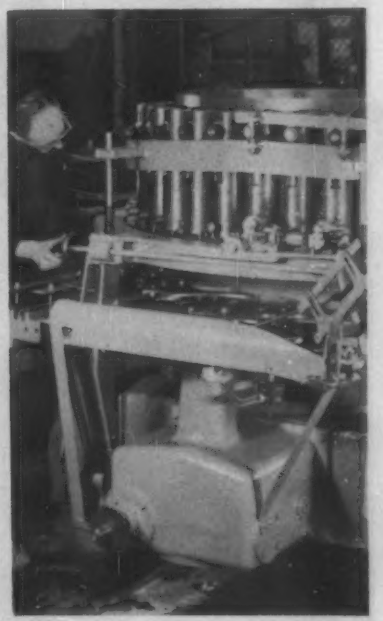
What does Rogers Cartage think of the glassed-steel tank truck? They just placed an order for a second unit.

For more details on this, contact your Pfaudler representative, or write for Data Sheet 29.

---

Sidelight: When the truck reaches Lever Brothers, it empties its payload into Pfaudler glassed-steel storage tanks which in turn empty through glassed-steel pipes, fittings, and valves. Such total use of glassed steel from receiving to process is becoming more and more common, particularly where product contamination is a problem.

## New filler takes 600 quarts of lube a minute without spilling



Here is the new Pfaudler RPL-36 Lube Filler.

It fills 600 quarts to the minute even with highly viscous liquids.

There's more than speed here, though. The machine also shines in accuracy. It will fill within one-tenth fluid ounce of a can's volume without spilling a drop. Such accuracy saves product and also assures a clean package and carton.

A fast check of other features reveals: filling adjustments made easily from either side while the RPL-36 is running; uniform acceleration of the infeed screw prevents jamming of empties at high speeds; positive, high-speed *no-can-no-fill;* piston and valves made of non-rusting Ni-Resist; all gears enclosed in oil bath for continuous lubrication.

Write for Bulletin 964 for the complete story.

---

**PETROLEUM EQUIPMENT**
**by PFAUDLER**
**a division of PFAUDLER PERMUTIT INC.**
**DEPT. PR-48, Rochester 3, N. Y.**

See also Chemical Engineering Catalog, pages 1407 through 1418.



For more data on advertised products, use Readers' Service Cards, last page.

## Time for a look at process economies?

Faced with stiffer competition and climbing operating costs, more and more process engineers are finding that L&N precision analytical equipment "pays off" in savings . . . by increasing process efficiency and product yield.

When you're looking for economies, talk with our engineers about precision analytical instruments for sulfuric acid production, ethylene product analysis, and many other chemical and petrochemical processes. You'll find that L&N not only supplies advanced electronic Speedomax® recorders, indicators and scanners, analyzer cell systems and electric and pneumatic control systems, but sound answers for instrumentation problems involving:

**Temperature**—*for all industrial applications featuring entire temperature spectrum by thermocouple, Thermohm® or Rayotube® sensing elements.*

**pH**—*for control of process solutions.*

**Electrolytic Conductivity**—*for detection of condensate purity and control of some processes.*

**Thermal Conductivity**—*for binary and simple gas mixtures.*

**Gas Chromatography**—*with Chromomax® for analysis of process streams.*

**Infrared Analysis**—*for multi-component gas mixtures.*

**Magnetic Oxygen Analysis**—*for $O_2$ control in combustion processes, protective atmospheres, etc.*

**Air Pollution Monitoring**—*with the preferred Thomas Autometer.*

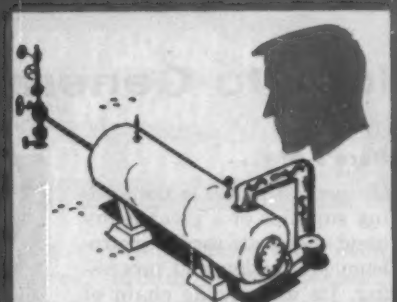
For further information on L&N equipment for chemical, petroleum and allied industries, talk to the men at our nearest office, or write to Leeds and Northrup Co., 4923 Stenton Ave., Phila. 44, Penna.

**LEEDS** [LN] **NORTHRUP**
Instruments — Automatic Controls • Furnaces

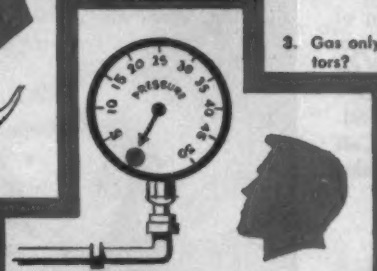
# are you in these pictures?

1. Liquids in flare gas going up in smoke?

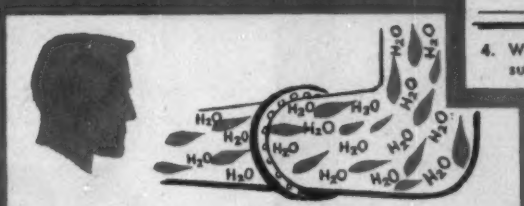
2. Gas too wet for pipelines?



3. Gas only partially stripped by separators?

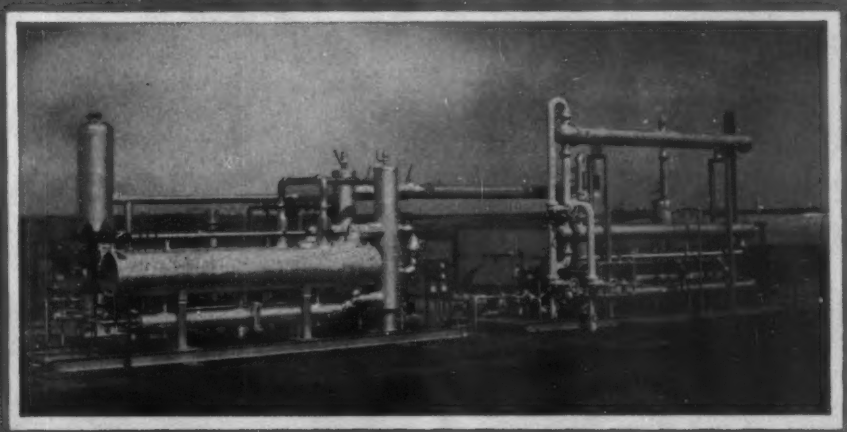



4. Well head pressure too low for pressure drop refrigeration?




5. Dehydration problem?

## if so, CHILLGAS has the answer!



- UNATTENDED OPERATION
- HIGH LIQUID RECOVERY
- DEHYDRATES WITH NO ADDITIVES
- NO PRESSURE DROP IN GAS STREAM
- LOW OPERATING COST — USES WASTE VAPORS FOR POWER
- SELF-ADJUSTING TO LOAD CHANGES

# CHILLGAS

CHILLGAS CORPORATION • HOUSTON, TEXAS

Clip this coupon to your company letterhead and obtain further information on the above:

Chillgas Corporation
P. O. Box 2536 — Dept. 6718
Houston, Texas

I want to know more about Chillgas

Name_____

Position_____

# When you need

# BASIC CHEMICALS FOR PETROLEUM

# look to General Chemical!

***Here's why...***

General Chemical is the leading supplier of a great many basic chemicals used in petroleum production and processing. Its nationwide chain of plants and warehouses, large-scale production, extensive research and technical service—all assure you of really dependable products and service. Call on us for these key chemicals:

**ALKYLATION**
Anhydrous Hydrofluoric Acid
Sulfuric Acid

**POLYMERIZATION**
Fluosulfonic Acid $HO{:}SO_2F$
Boron Trifluoride
Sulfuric Acid

**SULFONATION**
Sulfuric Acid
Sulfan® (Stabilized Sulfuric Anhydride)
Oleum

**ISOMERIZATION**
Hydrochloric (Muriatic) Acid

**DETERGENTS, CLEANERS & BUILDERS**
Sodium Metasilicate
Disodium Phosphate
Sodium Sulfate, Anhydrous
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate

**ACIDIZING**
Hydrochloric (Muriatic) Acid
Hydrofluoric Acid
Sodium Bifluoride

**MUD CONDITIONING**
Sodium Silicate
Disodium Phosphate
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate

**GREASE MAKING**
Aluminum Sulfate

**ACID TREATING**
Sulfuric Acid
Sodium Silicate

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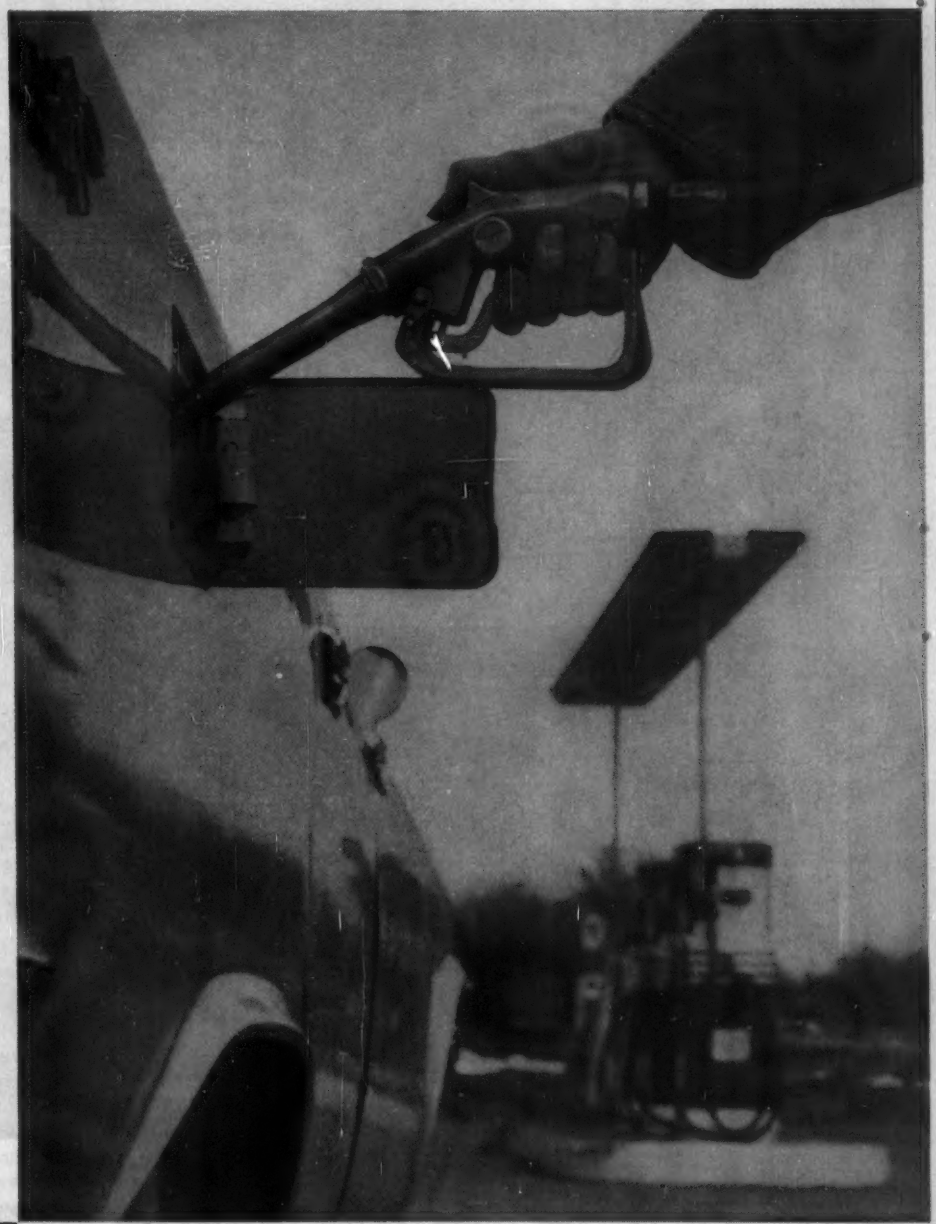

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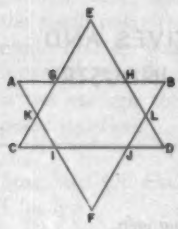
## The Mail Box . . .

### Trapped?

To the Editor:

The recent article "The Elusive Art of Thinking" (February PR, Page 199) contained an error in Example 3. The author fell into his own trap—that is he made an unnecessary assumption. The problem didn't state that all four equilateral triangles had to be the same size, therefore a two-dimensional solution is possible. Triangles EGH, ECD, FAB, FIJ are all equilateral triangles and there are also four more smaller equilateral triangles —AGK, CKI, BHL and DLJ.




Donald E. Holly

Ypsilanti, Mich.

### Beads and Hunter

To The Editor:

The article "The Elusive Art of Thinking" proved most interesting and stimulating.

I was particularly intrigued by the "bead problem" in that the author states that 'the only solution is to break the beads with some available "tool".' It would appear that the author also has some preconceived notions to overcome. At least one additional solution involves an "operation" on only one bead (the middle of the five consecutive black ones) with a can of white paint and brush. The instructions contain no prohibition against changing the colors of any of the beads.

A second point of interest arises in the "hunter problem." The majority of readers will hastily conclude on the basis of geography that such a trip could be made only if the hunter's camp was located at the north pole and thus the bear polar and white. While the final conclusion is correct, the intermediate reasoning is wrong. It is interesting to note that there are an infinite number of points in the southern hemisphere which conform to the geography of the problem. These points are located on the parallel of latitude located one mile north of the parallel which has a circumference of one mile. Thus, the hunter could walk south one mile, to the

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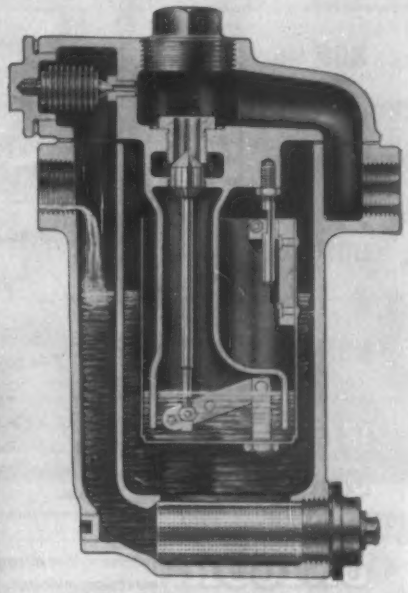

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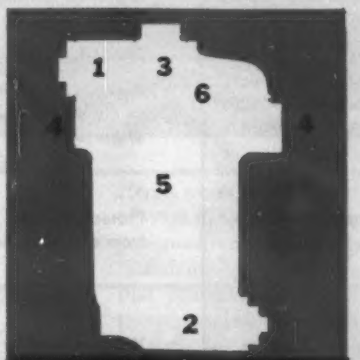


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## The Mail Box . . .

parallel with a one mile circumference, then walk west one mile which returns him to the point from where he started walking west. Interestingly enough, there are no polar bears in the south polar region so we can conclude that he was at the north pole, however, the description of the trip is not enough to establish the north polar location.

Philipp W. Binzel
Standard Oil Co. (Indiana)
Chicago

### Civil, Not Chemical

To the Editor:

The presentation of my paper "Save on Pipe Support Foundations" which appeared as part of your Special Report in the March issue (Page 150) is excellent. The effort that had to be expended in having all those complicated mathematical expressions just right is fully realized and appreciated.

In connection with the data presented in the accompanying author's sketch, I would like to point out that my employment with The Girdler Company was with the Gas Process division and that the academic training that I obtained in the institutions listed is in the field of civil engineering.

It has been a pleasure writing this paper for PETROLEUM REFINER.

Stanley H. Fistedis
Argonne National Laboratory,
Lemont, Ill.

### Wants More

To the Editor:

I have just read Mr. O. R. Roberts' excellent article, "How to Estimate Piping Labor" appearing in your March, 1958 issue, and would be interested to know if similar data has been developed for fabrication and erection of stainless steel piping.

G. O. Young,
The Chemstrand Corp.
Pensacola, Fla.

*Editor's Note—Future articles by Mr. Roberts are planned covering fabrication and erection costs for alloy materials as well as other pressure classes.*


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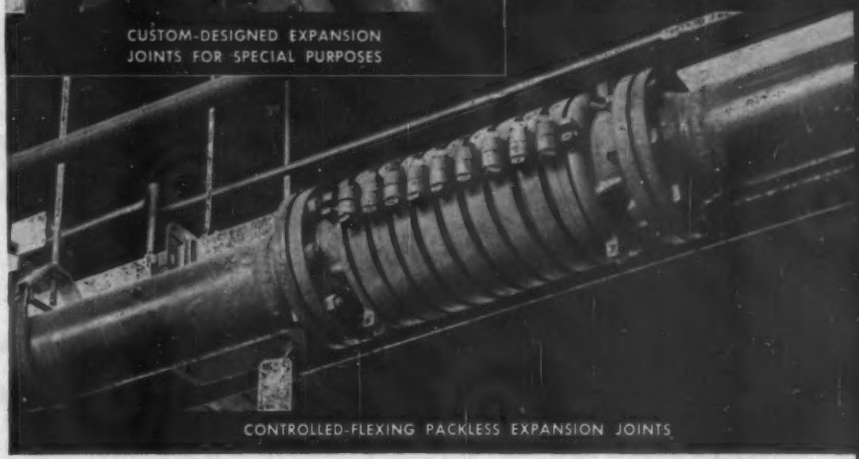

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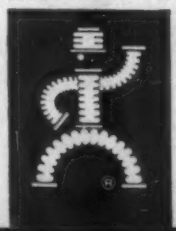

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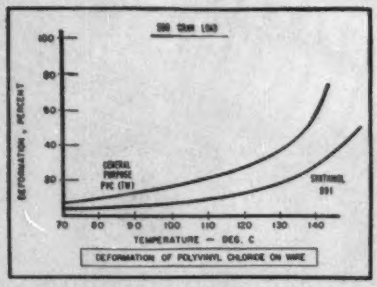
# Troubled with wiring failures in your refinery?

If so, consider the record being established by Rome Synthinol 901, a special 90° PVC compound for wire insulation and sheathing. It has helped to solve an impressive list of difficult wiring problems.

Developed by Rome Cable's laboratory and first introduced in 1949, Rome Synthinol 901 has proved by test and actual use to be superior to conventional PVC compounds in the following ways:

a. Suitable for continuous operation at higher temperature (90°C).
b. More stable under severe heat cycling.
c. Suitable for continuous immersion in hot transformer oil.
d. Superior resistance to chemicals and solvents.
e. Greater resistance to heat deformation.




Graph shows heat deformation vs. temperature, and compares Synthinol 901 with conventional PVC compounds. Test run in accordance with Underwriters' Laboratories standard procedure, except for temperature.

The practical value of this compound can best be illustrated by describing a number of actual case histories.

### (1) Oil refinery, industrial and chemical plant wiring.

Plant and oil refinery engineers have long used conventional PVC insulations for plant wiring with good results, but too often heat deformation problems arose in warm locations. Since Rome Synthinol 901's superior deformation resistance suggested that it might be the answer to this problem, it was tried and soon became widely used because of its much better service record.

Synthinol 901 also proved to be far superior to conventional materials for chemical plant wiring where the corrosive action of chemicals and solvents has always been a tough problem. Although polyvinyl chlorides as a class have inherently better resistance to chemicals and solvents than many other materials, some engineers desired even further improvement. One user decided to test a number of samples over a long period by immersing them in various concentrations of acetone, different alkalis, and butyric, propionic, and acetic acids. The results of this careful evaluation showed clearly that, when exposed to these chemicals, Synthinol 901 would last longer than any other PVC tested.

### (2) Oil-filled transformers.

Transformer engineers have long sought a cable construction to replace varnished cambric-insulated cable for leads in oil-filled transformers. These leads connect transformer windings and bushings and are constantly immersed in hot oil. One transformer manufacturer, encouraged by successful experience with Synthinol 901 on other applications, undertook a comprehensive study of the possible usefulness of this insulation in lieu of varnished cambric for high-voltage transformer leads. This study extended over a several-year period and proved to those engineers involved that there were at least four reasons for standardizing on Synthinol 901 for this application:

a. There was less sludge in the oil than when VC insulation was used.
b. There was no harmful degradation of the electrical properties of the oil.
c. Conductors insulated with Synthinol 901 ran cooler, permitting a 7% increase in lead cable current rating.
d. The use of Synthinol 901 in lieu of VC would permit substantial dollar savings.

### (3) Coil leads.

Many manufacturers of small coils for relays, small transformers, small motors, and electronic components have tried to use PVC insulated lead wires for many years. Typically, these leads are crimped or soldered to the ends of the coil; and the whole coil is then impregnated with varnish or wax and baked as long as 16 hours at temperatures as high as 150°C. The varnish used may be asphaltic, phenolic, alkyd, etc.; and the wax may be paraffin, beeswax, carnauba, or another kind.

PVC insulated lead wires frequently produced serious production problems because of the insulation's tendency to shrink, crack, and stiffen during the impregnation and subsequent baking period. Synthinol 901 was substituted in place of the ordinary PVC insulation and, after nearly eight years of wide usage, not a single case of shrinkage, cracking, or stiffening of insulation involving Synthinol 901 has been brought to our attention.

These case histories describe just a few of the applications for which Rome's Synthinol 901 has proved especially effective. Perhaps they will suggest other applications in your own area which might also be better handled with Rome Synthinol 901 instead of a conventional PVC compound. If you have a wire or cable problem that might be solved with Rome Synthinol 901, why don't you get in touch with us? Contact your nearest Rome Cable representative for more information—or write to Department 320, Rome Cable Corporation, Rome, N. Y.

**ROME CABLE**
CORPORATION

# A Quick Look at the Industry THIS MONTH

***Ike Orders Imports Cut Again*** . . . Late last month President Eisenhower ordered imports of foreign crude cut by what amounts to slightly under 6 percent. Cuts will come only from East and Gulf coasts, and will reduce total imports by 58,400 bpd.

**Ike also proclaimed use** of the "Buy American" Act to whip non-conformists into line. From now on, unless a domestic product is unavailable or priced too high, purchase of non-domestic product will be made only if it is part of an import quota. In other words, those companies which don't stick to their quotas won't get government oil contracts.

**New plan goes further than some wanted,** but not as far as others would like. For some time, the Administration has been slowly squeezed by steadily increasing pressure from two opposite directions. On one hand, domestic producers plagued by bulging inventories and slumping demand, and with powerful support in Congress have been clamoring for mandatory controls.

**From the other direction was the constant threat** of adverse effects on friendly foreign exporting countries. These include Canada, Venezuela, and most notably, the Middle East where friends are few and far between. All three will be affected—and they won't like it a bit.

***But How Much Will This Accomplish?*** . . . That's the big question only time can answer. One trend of thought is that natural gas has absorbed a great part of the market previously reserved for domestic crude. Since foreign crude captures only 5 percent of nation's energy requirements, natural gas may have contributed more to the unstable situation than foreign crude.

***And in Venezuela the Situation Looks Uncertain*** . . . In recent Caracas conference, Venezuelan officials said in no uncertain terms they opposed any plan which would cut back oil production. New government headed by Wolfgang Larrazabal was quick to guarantee that previous governmental oil commitments would be honored and that private enterprise would be encouraged. A three-page statement to oil men concluded, "In view of this hour of responsibility, Venezuela offers you guarantees, and you owe her your cooperation." By "cooperation" they no doubt meant "lay off any imports restrictions."

***A Quick Look At Nuclear Reactors*** . . . Now that three nuclear reactors are producing electricity in the Western world, industry is watching closely to see what cost reductions can be made. Though price of uranium is now competitive with conventional fuels, cost of fuel is only small part of total. Best estimates for U. S. are that nuclear plants produce electricity for 12 mills per kilowatt hour—twice the cost of that produced conventionally. In Britian where cost of coal is higher, gap is narrower. But for immediate future, petroleum is still cheaper route to electricity.

**Meanwhile, British announcements of $H_2$ fusion control** make this method a good bet for electrical generation in the distant future; probably more attractive than solar energy.

***A Quick Pan Over the Country*** . . . During the recent cold spell, Phillips' shipments of LPG were three times the usual rate. Company was supplying daily volume equal to half nation's normal requirements . . . Even in the face of slashed allowables and terrific gasoline stocks, Rep. Jensen (R-Iowa) is urging legislation to require use of 5 percent grain alcohol in motor gasoline . . . A German-built diesel engine taxi

is reportedly operating at such a saving in fuel cost, it was well worth extra price for the vehicle.

***Liquid Hydrocarbon Count Down . . .*** Production of liquid hydrocarbons in the U. S. exceeded the amount of new reserves added during 1957. This means a net loss in proven reserves for the first time since 1943. For a quick summary of the latest estimate of reserves see report on Page 269.

***Latest Octane Postings . . .*** Ethyl survey of major U. S. cities shows premium octane averaged 98.5 F-1 for March, unchanged from the February average. Also regular held steady to the March average of 91.1.

***Rubber Having Its Ups and Downs . . .*** The rubber picture bounced high and low last month, but in general it still looks pretty good.

**Rubber balls tough enough to contain 269 tons** of air pressure helped put Explorer I into orbit. New rubber compound less than one-eighth inch thick stops air leakage even at 3,000 psi.

**Man-made rubber which equals** or surpasses natural rubber was successfully tested. It has the same molecular structure as tree rubber.

**U. S. consumption of new rubber** may reach 1.635 million long tons by 1960—an increase of 151 percent in the past 20 years. Last year's rubber consumption hit the 1.469 million-ton mark with three-fifths of it synthetic.

**Du Pont started production** of a new family of elastomers which will reportedly excel all others in heat and chemical resistance.

**On the gloomy side of the ledger,** we find an excess of butadiene—the most important ingredient of synthetic rubber. Combination of soft market and sharp decline in natural rubber price paints a dark picture for butadiene manufacturers. One silver lining is possibility of upturn in new car production.

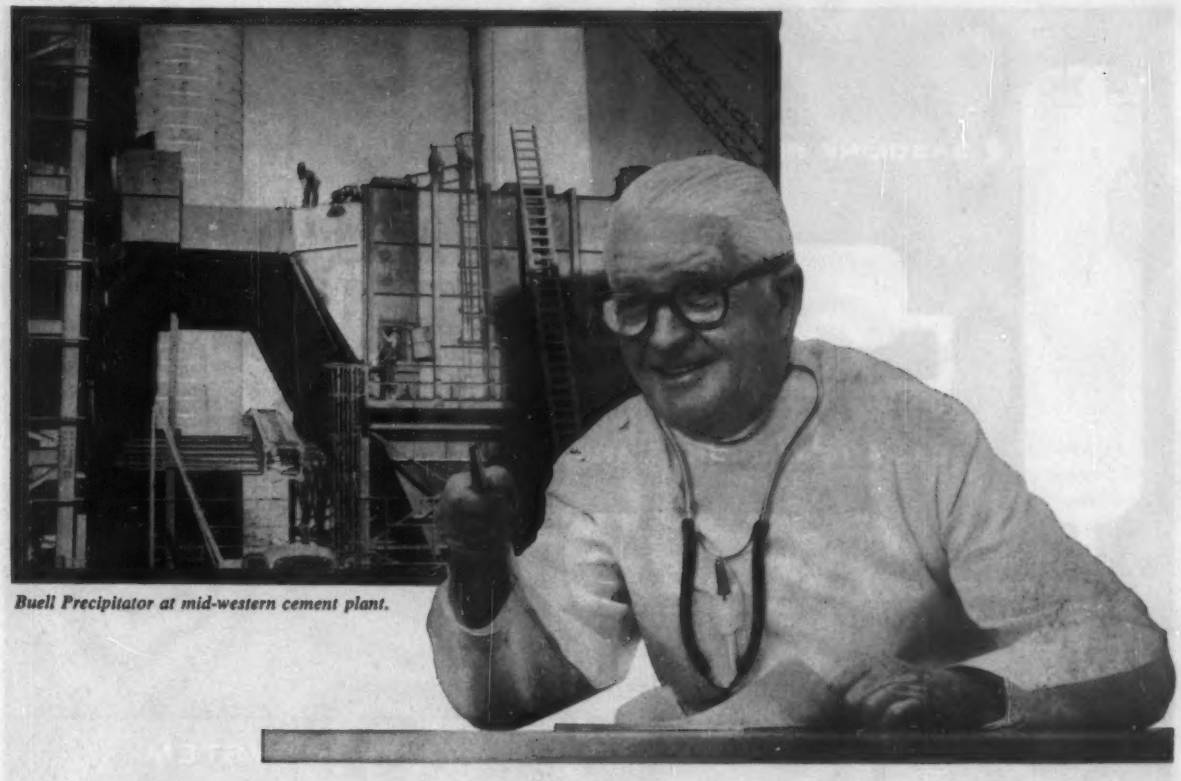
***A Quick Look at Washington . . .*** House Committee has opened hearings on bill to prohibit operation of vehicle which emits "excessive" exhaust gases . . . **Supreme Court has put off** until next Fall any decision of the Memphis Case . . . **FTC has ordered** Mohawk, Salyer, and Double Eagle refiners to quit selling product without disclosing on containers and in ads it is made from used oil . . . **Representatives of large city** Mayors' group have asked Speaker Rayburn to call Harris-O'Hara natural gas bill to a vote to give foes chance to defeat it.

***Shale Getting Far Eastern Boost . . .*** Look for a joint Japanese-Thailand company to embark on a shale oil venture in the near future. Shale holdings in the northwestern section of Thailand near Burmese border amount to about 3 billion tons. Company is planning a plant with 6,000-bpd output based on promise of 26 percent shale yield.

**Meanwhile, British Petroleum subsidiary,** Scottish Oil, is planning experiments with underground shale retorting. Company will drill horizontally, then ignite the shale on the theory that gas from underground fire will condense at ground level into crude.

***Vapor Cooling May Get Big Play . . .*** Along maintenance lines, vapor cooling of compressors may be the trend. Tidewater has been using this system in one plant to the tune of a 45 to 50 percent reduction in compressor maintenance costs.

***Natural Gas Producer Finances Solar Experiment . . .*** Those who think oil and gas people act only in their own self-interest will be hard pressed to explain recent action of Godfrey L. Cabot. Although a producer of natural gas, Cabot financed an MIT project to build an experimental home heated by solar energy. There is also an oil burner for use during long cloudy periods. House has glass roof inclined at 60 degrees from the horizon facing south. Occupants will not throw stones.



*Buell Precipitator at mid-western cement plant.*

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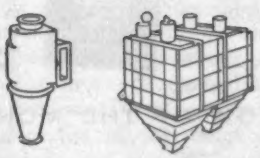

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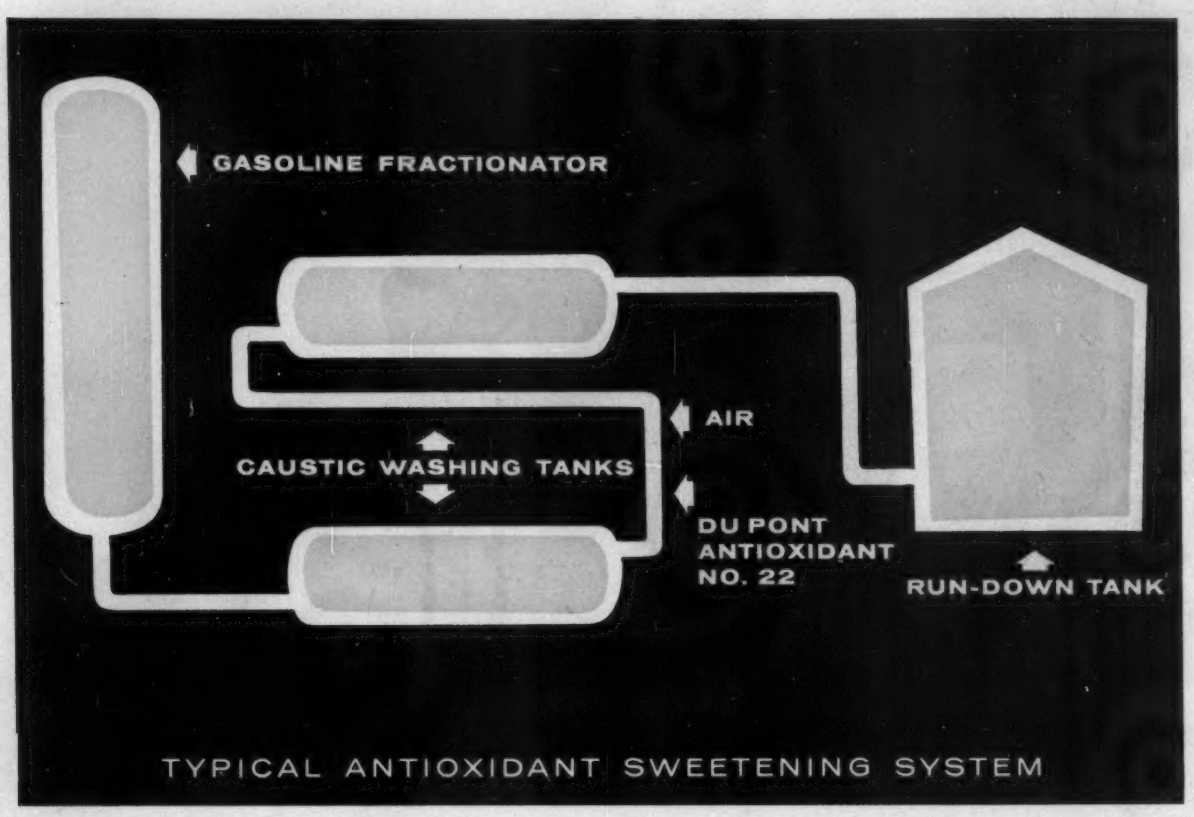


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# Reduce treating costs...

## sweeten with antioxidant 22

BY HAROLD J. SCHEULE

With one additive you can take two steps—important ones—in treating gasoline: stabilization *and* sweetening. Du Pont Antioxidant No. 22 (AO-22) is a sweetening agent as well as a stabilizer. And in a single, inexpensive operation both objectives can be attained.

The equipment for sweetening with antioxidants is much less expensive than other types of sweetening equipment. Or, if you prefer to continue using your present equipment, the cost of converting it will be extremely low. The advantage of low operating costs is available either way.

Another important advantage of sweetening with Du Pont AO-22 is that no undesirable chemicals such as sulfur or copper are added to the product. Therefore, the chance of contamination from these elements is eliminated. Also, there is no loss of gasoline or octane number when sweetening is done with AO-22.

### Complete line

Since Du Pont supplies a complete line of gasoline antioxidants, our representatives are qualified to advise you on all types of gasoline stability problems.

In addition to Antioxidant No. 22 (N, N$^1$-di-secondary-butyl para-phenylenediamine), the Du Pont line includes gasoline Antioxidants No. 5 (50% N-normal butyl-para-aminophenol) and No. 29 (2,6-di-tertiary butyl-4-methylphenol).

THIS BOOK contains detailed information about all three Antioxidants. Ask any Du Pont Petroleum Chemicals representative for a copy, or write us. E. I. du Pont de Nemours & Co. (Inc.), Room 2420-15 Nemours Building, Wilmington 98, Delaware.

HAROLD J. SCHEULE has for three years been supervisor of the gasoline group. This is part of the Product Application and Service Division of our main Petroleum Laboratory, Carney's Point, N. J.

See the "DU PONT SHOW OF THE MONTH" on CBS

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# Our Part in Exotic Fuels

A NEW INDUSTRY for the manufacture of high-energy fuels and rocket propellants is fast moving in upon us. Spurred on by our continuing desire to go faster and further, this new industry is attracting a number of companies which already are in the oil business. Several oil companies have figured prominently in recent news releases.

Frontier Refining Company is among the latest to announce plans for the manufacture of high-energy fuels. It has a major interest in the newly formed Metal Alkyls Corporation which plans to make these fuels in both test and commercial quantity.

Phillips Petroleum Company earlier joined North American Aviation to form the company Astrodyne. The jointly owned company unites the activities of its parents to expand the field of solid propellants.

Gulf Oil Corporation has an interest in the new fuels business too, but its relation is a bit more strained. It owns 25 percent of Callery Chemical Corporation which, in turn, has a working agreement with the solid fuel pioneer, Thiokol Chemical Company. Furthermore, Thiokol announced a merger with the liquid fuel engine builder, Reaction Motor, to further work on high-energy solid fuels.

Another company going into the rocket business is Tennessee Gas Transmission. It recently acquired 75 percent of Grand Central Rocket Company.

**What are these fuels?** We are not sure. The wraps are not completely off the new fuels picture. There is a good possibility developments are being made along several lines, but most of these are believed to be based on a heavy metal derivative like boron.

Information is avaibable on boron and hydrogen compounds know as born hydrides. The high-energy fuels under current consideration are thought to be made by substituting an alkyl group or groups for some of the boron in the boron hydrides. A small alkyl group is best so as not to detract from the high energy properties of the basic boranes. One form of high-energy fuel is stated to be ethyl decaborane. Other forms are possible and modifications can be made to give varying product properties.

These alkyl boranes are the compounds which were so widely publicized in the initial stages of this multi-million dollar business. They were called "zip" fuels, and programs for their production were started by the Navy in 1952 and the Air Force in 1955.

Since then a number of new plants have been announced for the preparation of various materials which fit in with high-energy fuels. Metal Hydrides started a $5.5 million plant in Beverly, Mass., last fall to make sodium borohydride. Reports tell of Callery Chemical's plant to convert ethanol to ethylene. Presumably the olefin will be combined with the sodium borohydride to produce ethyl decaborane or one of the other forms of alkyl boranes.

**How do oil companies fit in?** The resources and technology developed by the oil industry is readily applied to the formation of high-energy fuels. We have a ready supply of inexpensive raw materials and a thorough knowledge of ways to transform them.

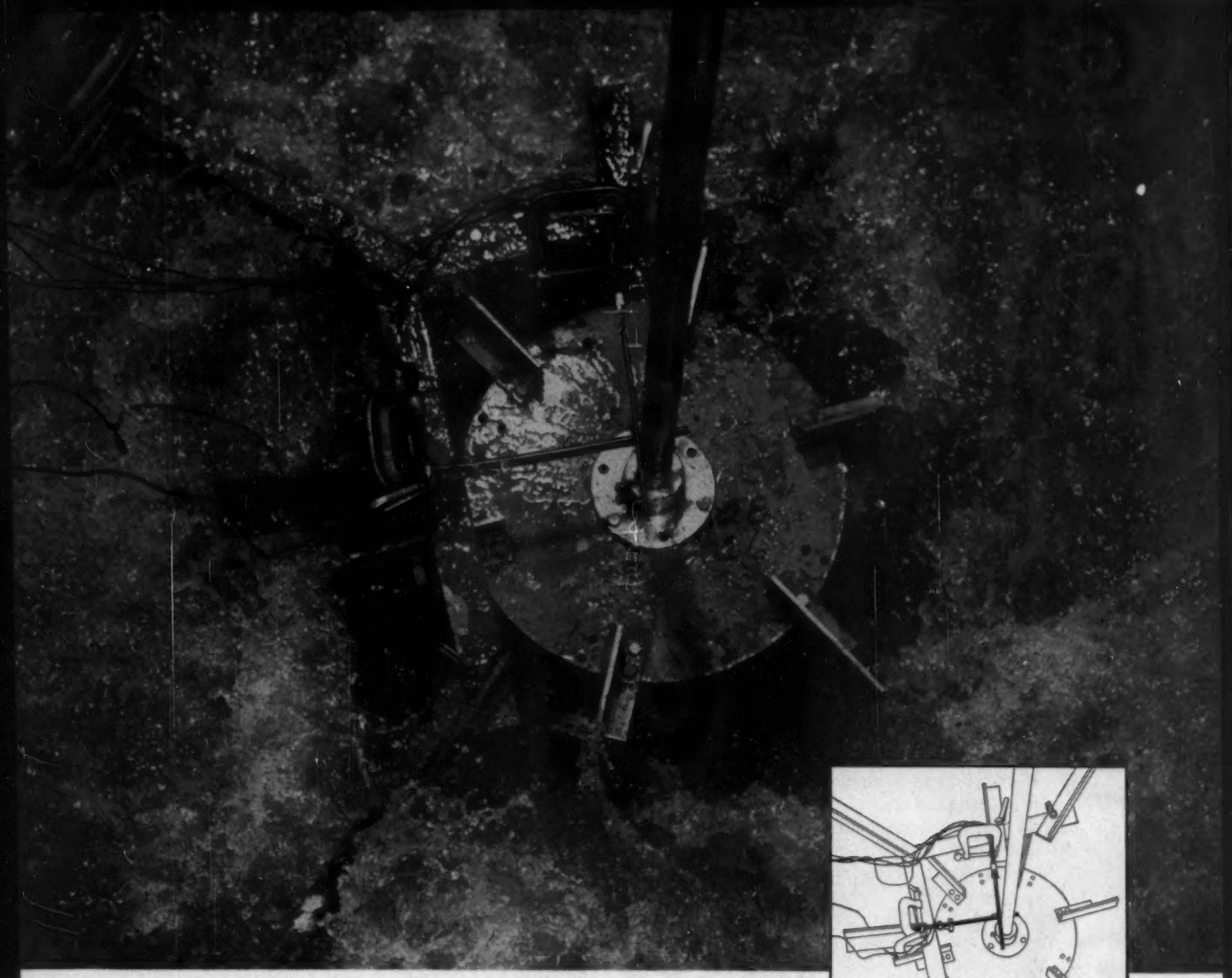
The union of hydrocarbons with heavy metals is a very likely endeavor for pulling together oil and heavy chemicals companies. Each type of company can furnish materials, equipment, and know-how for a particular phase of the operation.

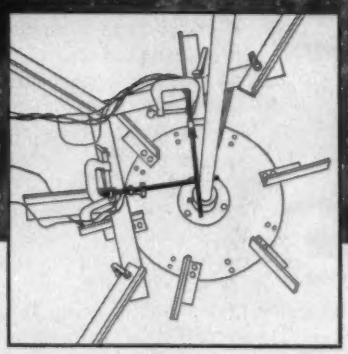
**The future of the boron fuel** is uncertain. To date, the government is sharing most of the cost of plant construction. The two plants now being built for fuel production (one by Olin Mathieson and the other by Callery Chemical) are expected to have a combined output of 3,400 tons per year. Their cost, along with the cost of pilot-size work is estimated to be about $75 million.

What are the limits of these fuels? Some of them could be burned in a turbine engine of somewhat conventional design, but they would lay down deposits which could not be tolerated for long. In the afterburner of a turbine or in a ram-jet engine, the boron fuels produce combustion products which are very corrosive and abrasive. Therefore, a great deal of research still is needed to make the fuels and engines compatible. The new chemical bomber, The WS-110A, is being especially designed to overcome the disadvantages of burning these fuels.

In any event the future of high-energy fuels will be heavily subsidized for military use. The present popularity of the reciprocating engine in commercial aircraft will give no help to these up-and-coming materials. Even future commercial applications are expected to be shared between only aviation gasoline and jet fuel.

The development of high-energy fuels is a big





# *How to make a splash* **scientifically**

The road to better fluid mixing has some strange bypaths.

Here, for example, we're trying to find out what happens to a rotating mixer shaft *when the tank is empty,* or nearly empty.

Why? Plenty of people (yourself included, perhaps) can improve uniformity or yield by mixing at extremely low liquid levels while a tank is being filled or emptied.

But to do this with a long overhung shaft you need special knowledge. Random surface forces shove the impeller back and forth, deflecting the shaft and setting up unusual stresses for which the mixer must be designed.

**Tracing shaft deflection**

The two steel fingers (shown in photo and diagram) take the pulse of the turning, deflecting shaft. They pass data through tiny flexible-wire pickups to an electronic recorder, which makes a running trace of the shaft's deflections.

The story told by this trace enables us to design mixers that will run stably at any desired speed or shaft length and will withstand the buffeting of forces that occur during filling and drawoff.

Typical of many continuing research projects at MIXCO, this work helps fluid mixing advance from art to technology. It helps you plan for more efficient use of mechanical mixing in your processes.

If your work involves efficient mixing of fluids, we can supply time-saving data, suggestions, or calibrated research equipment. For details, see your LIGHTNIN Mixer representative now. He's listed in Chemical Engineering Catalog. Or write us direct.

**Lightnin® Mixers**

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**MIXING EQUIPMENT Co., Inc., 164-d Mt. Read Blvd., Rochester 11, N.Y.**

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step in expanding our energy resources. However, its bid for a part of the oil industry's market is mighty small. The field of most likely entry is in air travel and this field, of course, receives only a minor portion of our products.

According to figures by the Bureau of Mines, the total aviation gasoline produced in the U. S. last year was only 3.9 percent of our products from crude oil. Jet fuel was 2.2 percent. There is due to be a gradual swing from aviation gasoline to jet fuel, but high-energy fuels have no place in commerical air travel at the present time. This leaves a mighty narrow field of application for the exotic fuels—their future being linked with the interest in rockets and missiles.

### Let's Teach "Living"

NO DOUBT, there will be some reshuffling of ideas as to what is needed in high school curricula in order to meet the space age needs of more scientists and technicians. One surprising point was brought to our attention recently, however, by the Association of Casualty and Surety Companies which stated that several educators have pointed to driver education classes in high schools as the kind of "frill" that deprives schools of sufficient time for basic education.

We have no quarrel with competent school authorities, because they, more than any others, are aware of what is needed in the form of teaching in the classrooms. Still, we would like to make this one point. In 1957, more than 13,000 young people died in automobile accidents; the greatest portion of an annual 40,000 dead. What we would like to know, and of course it is impossible to ascertain, is how many of these 13,000 would have grown up to be important, and perhaps even great, scientists.

The need for driver education is brought to light even more by an American newspaper writer who reports that the biggest public relations problem for American air bases in Africa arises out of auto accidents involving airmen and African civilians. This, of course, is a situation which gives America a black eye in an area of the world where diplomatic relations are touchy.

At these bases where there used to be safety slogans urging caution in the primary functions of military flying. The Association of Casualty and Surety Companies says that now the slogans and admonitions have to be directed to the hazard of foolish and reckless driving. How much easier and less costly it would have been if all of these young men would have been taught, if possible, the principles and habits of safe driving in high school.

So educators and school authorities should think twice before pointing an accusing finger at driver education as one of the "frills" that rob high school students of time needed for basic education. It will do well to remember that even though we may fly to the moon next year, we will still be driving on our highways; and our young people can't become scientists if they don't live long enough to get past logarithms.

### Biggest Bargain In All America

SOMETIMES we can't help but wonder if the average American driver—let's call him Mr. Joe Motorist—ever stops to think about that wonderful fuel that makes his automobile go—he calls it "gas." In fact, we think he might take issue with us if we told him that when the service station attendant puts a gallon of it into his car, he is getting America's biggest and best bargain. That is, he might take issue until we "give him the dope" and, incidentally, you might use a couple of these ideas the next time some of your friends start complaining about the high price of gasoline.

Let's say that Joe drives into a service station and orders one single gallon of gasoline. Now, when he subtracts the state and federal tax, that gallon is going to cost him less than a quarter. He may not realize it, but this makes gasoline cheaper than water, as a gallon of distilled water costs about 50 cents.

But that's not all. In addition to getting his one gallon of cheaper-than-water gasoline, he receives many services for which he doesn't pay. These are small courtesies extended by the oil company and which, by now, Joe has come to expect. The service station attendant will wipe his windshield, sweep off the floorboard, check his oil, battery water, radiator water, tires, and anything else which Joe may feel needs looking after. And he pays not one red cent extra.

Joe likely doesn't think to compare this with the "service" he received last month when his TV set went on the blink. It cost him a $5.00 "service" charge just for the repair man to come out to see what was wrong. It never occurred to Joe that on the same day he called the service station to come get his car to have it washed and greased—just for the price of the wash and grease job.

We can't help but wonder how many of those Joe Motorists in Washington who are yelling for elimination of the depletion allowance have driven into a service station on a cold winter night to have anti-freeze put into their cars—just for the price of the anti-freeze? How many of them pushing Bill S-11, which would drastically alter our gasoline marketing system, have had a fan belt changed—just for the price of the fan belt? How many of those who yell the loudest that oil companies are monopolistic and unfair have run out of gas and have called a service station for assistance—just for the price of the gasoline?

These things aren't taken into consideration when the oil industry is turned every way but loose by congressmen many of whom use the spotlight of pseudo oil investigations to gain personal recognition. The American people don't have any gripes about the way things are being run; to them the oil industry is represented by the courtesy of the service station attendants who fill up their tanks. It's up to us to remind them—to remind everybody. Truly, a gallon of "gas" still is America's best bargain.

# Ethyl Research takes a new look at octane improvement costs

## *Latest Study Aimed At Helping Refiners Cut the Cost of Meeting Road Antiknock Requirements*

Gasolines tailored to the same Research octane number specification may behave quite differently from one another in today's high-compression automobile engines on the road.

This complicates the refiner's ever-present problem of how to make the best gasolines, at the least cost.

ETHYL Corporation's Refinery Technologists—working with a leading process-development company—recently completed a study of the road performance of 18 premium-gasoline blends of different compositions. Results of this study are available to refiners as a guide in planning octane-improvement methods that offer a bonus in superior road performance.

### 1960 Refinery Used as Model

All processes and blending schemes compared were those which might be expected in a 1960 refinery. A series of 18 premium-gasoline blends were made up using the following stocks:

1. Light straightrun naphtha
2. Two isomerized light naphthas
3. Light cat-cracked gasoline
4. Three catalytic reformates
5. Butylene alkylate
6. Propylene alkylate
7. Propylene dimer
8. Propylene polymer

The blends compared in Figures 1 and 2 consisted of 40% $C_5$-$C_6$ fraction, 40% $C_7$ catalytic reformate, 20% butylene alkylate, 3.0 ml tetraethyllead, and enough *n*-butane for a 10 lb. Reid vapor pressure. Various process stocks were used for the $C_5$-$C_6$ fraction. The desired Research and road octane numbers were attained by changing severity of reforming.

A 7-octane spread was specified between the road rating of each premium blend and the Research rating of the corresponding regular-grade gasoline. Any cost of the addition of tetraethyllead to the regular grade needed to maintain this spread was charged to the cost of the premium blend in all process comparisons.

### Fuels Road-Rated in Engines Designed for the Future

Each of the 18 premium blends was road-rated at two tetraethyllead levels in six test cars. Two of the cars were 1957 models. Of the remaining four, three had compression ratios of 11-to-1, and one had a compression ratio of 12-to-1. This range of compression ratios permitted appraisal of the various processing schemes on the basis of satisfying predicted octane-number requirements of future cars.

### Research and Road Octane Costs Compared

In Figures 1 and 2, the costs of producing various premium fuels are compared from a zero level based on the cost of the straightrun-reformate-alkylate blend which rated 99 road octane number. The catalytic-reformate portion of this blend rated 98.9 RON at 3.0 ml tetraethyllead.

The isomerization curves are based on processing pentanes and hexanes from light straightrun naphtha and from light reformate. In one case (Isom I), only *n*-pentane was recycled. In the other (Isom II), total recycle produced isopentane and dimethylbutanes, to-

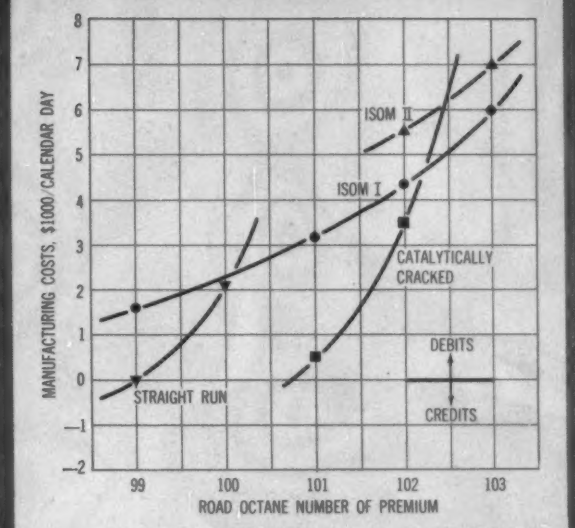


FIGURE 1. MANUFACTURING COST VS. ROAD OCTANE NUMBER OF PREMIUM GASOLINE

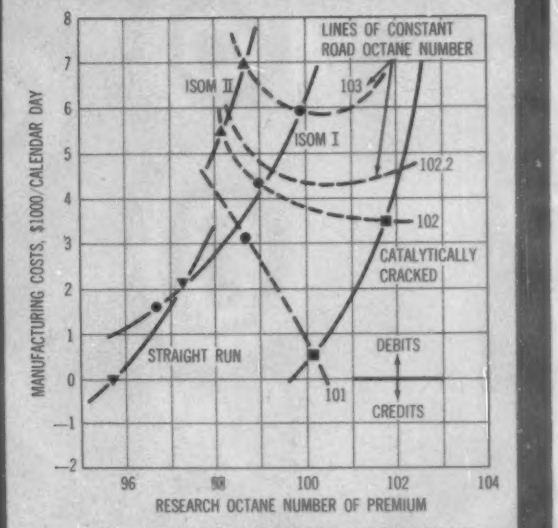


FIGURE 2. MANUFACTURING COST VS. RESEARCH OCTANE NUMBER OF PREMIUM GASOLINE

gether with a minor proportion of methylpentanes and naphthenes.

### Choice of Blend Changes Above 102 Road Octane Number

As shown in Figure 1, road performance can be attained at least cost by using a catalytically-cracked $C_5$-$C_6$ fraction in premium blends until a road octane number of about 102 is required. Further increases are attained more economically by isomerizing the light straightrun naphtha (Isom I) for blending to premium and diverting the cracked $C_5$-$C_6$ fraction to regular-grade gasoline.

At this transition point, calculations from the slopes of the curves indicate that the cost per road octane number barrel is greater than 15 cents with cracked $C_5$-$C_6$ fraction in the premium, as compared with about 5 cents using isomerized light straightrun. Beyond this point, Isom I becomes increasingly attractive because it does not require as great increases in reforming severity to attain higher road octane numbers.

### Isomerization Improvement Least Costly at High Road Octane Levels

Figure 2 takes both road and Research octane numbers into account. As can be seen, high RON's are obtained at least cost by using a $C_5$-$C_6$ fraction from catalytic cracking. However, the lines of constant road octane number show that fuels of the same Research octane rating differ considerably in road performance.

For example, at the 100-RON level, substituting Isom I for light catalytically-cracked stock raises road octane number from 101 to 103.

At a road octane number of 102.2, the two blend types cost the same amount to produce. However, the Research octane number required to satisfy this road requirement is three units lower with Isom I.

Beyond this point, the cost of improving road performance is approximately 7 to 8 cents per Research octane number barrel using isomers, as compared with a cost of 10 to 11 cents using cracked $C_5$-$C_6$ fraction.

This study illustrates the importance of analyzing octane-improvement cost on the basis of road antiknock performance rather than laboratory octane numbers alone. Such analysis can improve profits by cutting the cost of meeting actual octane-number requirements on the road.


## How Ethyl Research is helping you

Economic studies of octane-improvement processes are a continuing activity of Ethyl's Detroit Research Laboratories.

All of this research is conducted by Ethyl as a service to the Oil Industry—to assist refiners to achieve desired fuel quality and performance at the least possible cost.

The complete report made of this study is available through your Ethyl Representative. Just ask him for a copy of "Road Octane Improvement—A Basis for Process Evaluation."

**ETHYL CORPORATION**
New York 17, N. Y.

ETHYL ANTIKNOCK COMPOUND — ETHYL CORPORATION

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1600 W. Eight Mile Road, Ferndale 20, Mich.
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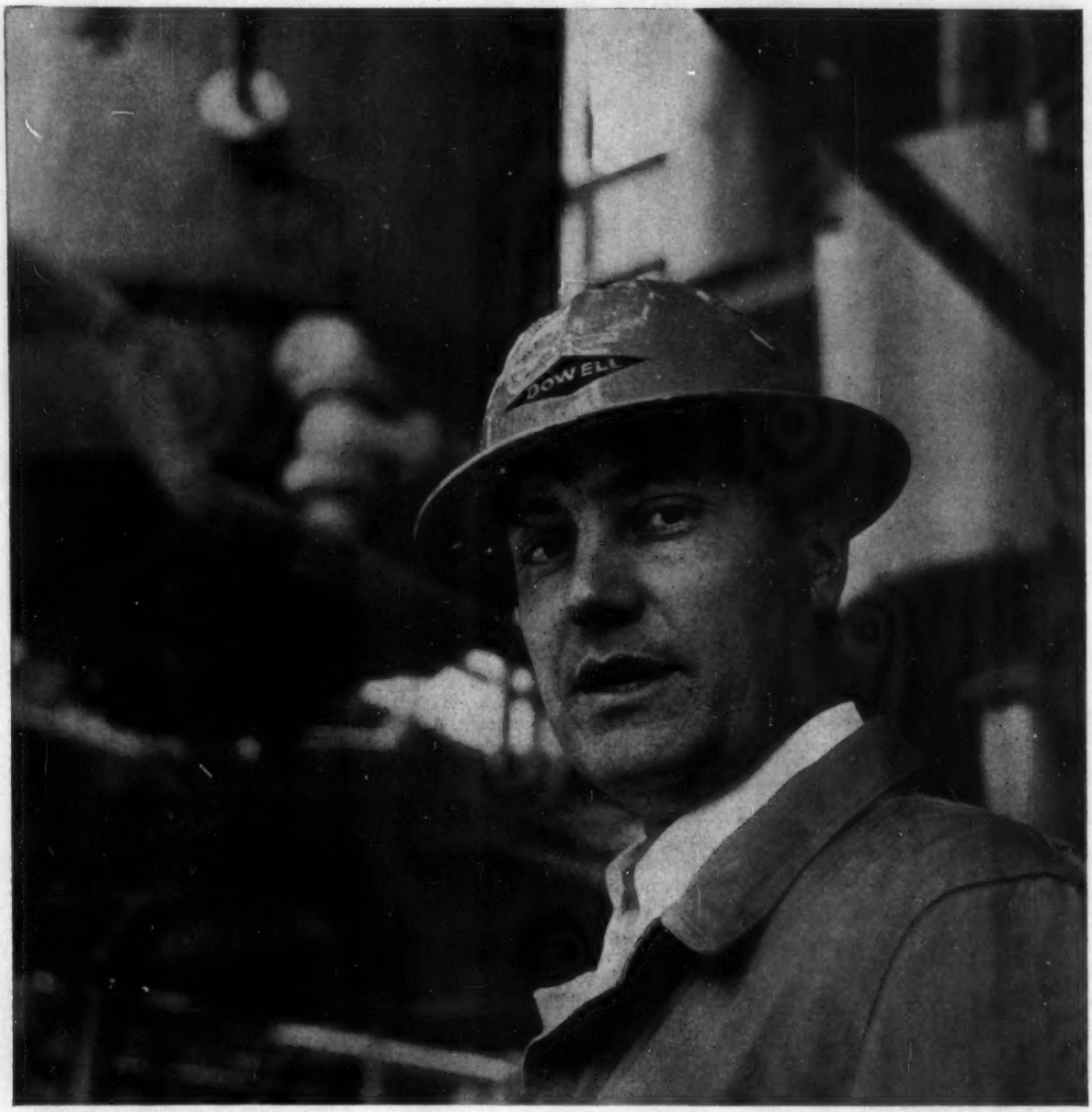


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Here's how one corporation employed the skill of the Dowell engineer and his group: Following construction and before the plant was put on stream, the company called in Dowell to remove mill scale.

Total cost of this mill scaling service was $5000. Once in production the plant did not have a single major shutdown for maintenance due to mill scale. Management of the plant credits Dowell service with helping them net an operating profit of somewhere between 10 and 20 times the cost of the chemical cleaning. That amounted to between $50,000 and $100,000 the first year.

With Dowell service you get 15 years experience in chemical cleaning, full lines of equipment and chemicals—plus an engineered job—performed by trained crews.

Every type of industry can profit from Dowell methods of chemical cleaning. Ask your maintenance and operating engineers if they have all the facts—the profit possibilities—on Dowell service. DOWELL INCORPORATED—A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa, Oklahoma; 165 offices and stations to serve you.

*Chemical cleaning services for industry* DOWELL

Petroleum Refiner April,1958

a Special Report

# NATURAL GASOLINE

Every natural gasoline plant is looking for ways to make production more efficient. In this report you will find these ways to cut costs and meet new product demands: How to automate a plant (Page 136)· How to use computers in plant design (Page 140) · What to do about algae (Page 141) · Where to cut lubrication costs (Page 145) What the new ammonia cycle plants are like (Page 147) · The way to make plants safe (Page 149)

# How This Plant Went Automatic

**Union found a good payout in converting its Playa Del Rey plant to unattended operation. Here's how they did it and what it cost them.**

**J. A. Gordon**
Union Oil Company of California, Los Angeles

THE PLAYA DEL REY natural gasoline plant is a small, conventional, oil absorption type natural gasoline extraction plant owned and operated by Union Oil Company of California. Located on the coast of Southern Caliofornia approximately 15 miles from Los Angeles, the plant treats low pressure wet gas from the nearby Venice Oil field at approximately 37# and high pressure gas from the Playa Del Rey gas storage reservoir at approximately 300#-500#. Current volumes treated are approximately 2,000 Mcf/d of low pressure gas, and approximately 3,000-4,000 Mcf/d of high pressure gas. Gasoline production is 6,500 gallons per day of a 48# Reid Vapor Pressure product.

In May 1955, three H.R.T. steam boilers in the absorption plant were condemned by the Division of Industrial Safety of the State of California. It became necessary to replace the boilers with new ones, or to modify the cycle in order to eliminate the need for boilers. An investment of $45,000 was required to replace the boilers. It was decided, however, to eliminate the boilers and to spend an additional sum to modify the cycle by going to automatic, unattended operation which would prolong the economic life of the plant. This would be accomplished by replacing the three boilers with a direct fired oil heater to heat the rich absorption oil to a higher temperature than that required for the still column, and to generate agitation steam with the hot oil in a new steam generator. Elimination of the boilers and all steam requirements except for agitation would then make it possible to operate both the absorption and compressor plants automatically and unattended except for occasional field supervision.

Work was started by Southern Engineering and Construction Company on April 25, 1955, and completed on June 8, 1955. During this period the

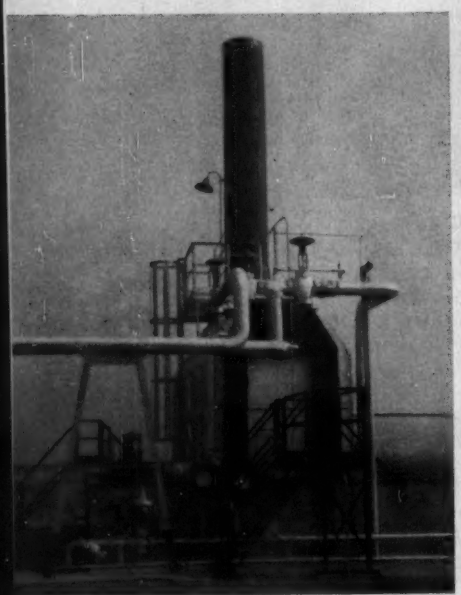

FIGURE 1—First step was to replace condemned boilers with a direct fired heater system like this.

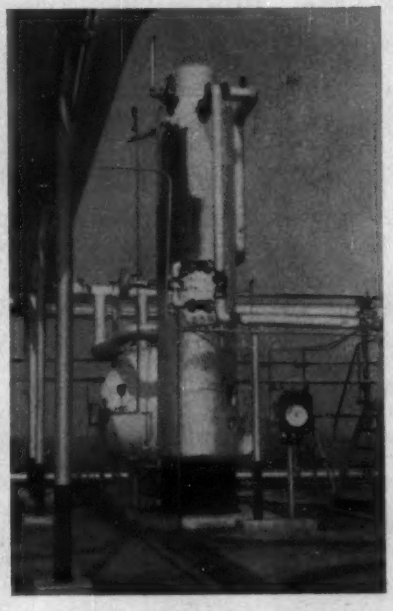

FIGURE 2—The steam generator uses hot rich oil in the tubes; water is on the shell side.

**HOW THE PLANT CONVERSION PAID OUT**

**Additional Investment $47,300**

Direct Fired Heater
Steam Generator
Oil Reclaimer
Gas Separator
Auxiliary Equipment

**Savings in Operating Cost $21,600**

Labor
Water and Electricity
Boiler Maintenance
Water Treating
Fuel

**Payout (years) 2.2**

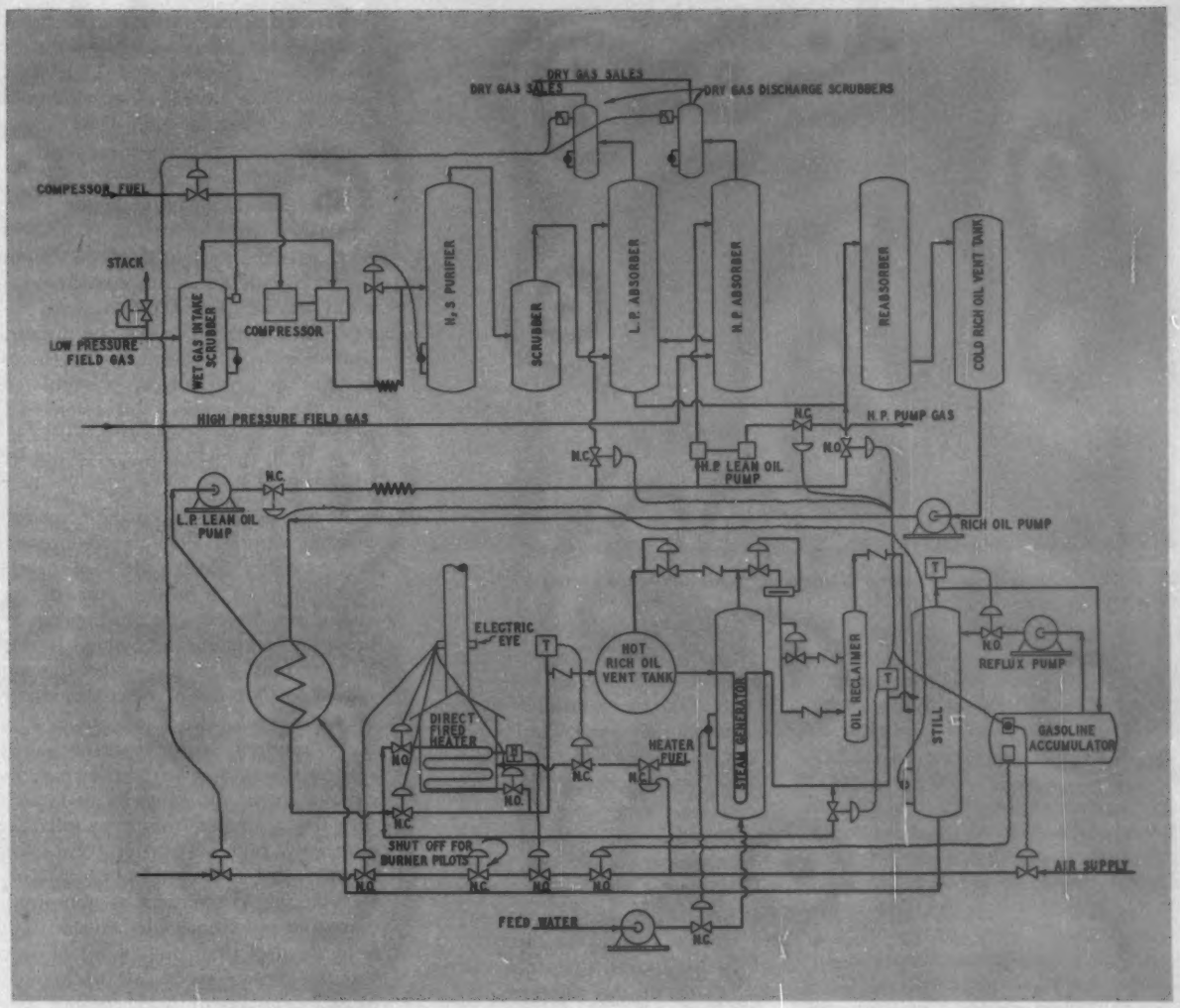


**FIGURE 3—Flow scheme for Del Rey absorption plant: Unattended operation is made possible by the non-use of steam except for agitation and the use of gas and electricity for power and standby pumping.**

plant operated on the old system and only one shutdown of short duration was required to tie in the new equipment.

**Flow Scheme.** The compression and absorption plant flow sheet is shown in Figure 3. Basically, the absorption cycle is unchanged from the conventional. The unattended operation is made possible by the non-use of steam except for agitation and the use of gas and electricity for power and standby pumping. The only attendance required is for routine maintenance and the daily manual draining of water from the low pressure absorber, steam generator, condensate accumulator, and the sampling and shipping of gasoline. Oil and reflux rates also are occasionally required to be manually changed. A travelling field operator periodically stops at the plant during the night hours to check if the operation is normal.

The direct fired heater is shown in Figure 1. The heater is gas fired and has a rating of 9 million Btu per hour. It is designed for a thermal efficiency of 80 percent plus.

The direct fired heater heats the rich oil to 400 F. which is 40 F. higher than that required for the still operation. The additional heat is used to generate agitation steam in a steam generator.

The heater is equipped with six burners each of which has a safety pilot shut-off control. An electric eye in the stack detects the presence of smoke. A high temperature shut-off prevents overheating. The heater fuel is shut off automatically from any of the following causes:

1. If the oil in the heater rises to a maximum of 505 F., a temperature controller shuts off the heater fuel.
2. If there is a coil leak inside the heater, an electric eye detecting smoke in the stack shuts off the heater fuel and bypasses the heater.
3. If the absorption plant gasoline accumulator liquid level controller fails, a high level alarm shuts off the heater fuel.
4. If three of the six pilots on the heater go out, the heater fuel is shut off.

If any of the above reasons operate to shut off the heater, a drop in oil temperature from 360 F. to 320 F. at the still will cause the lean oil to bypass both absorbers which prevents the lean oil from loading up with gaso-

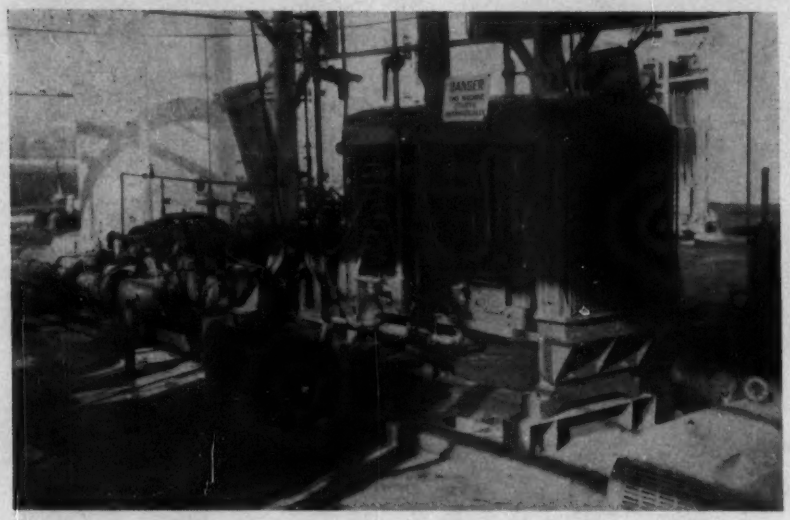

FIGURE 4—Spare lean oil pump: It starts automatically when there's a drop in lean oil pressure.

line. At the same time the top temperature of the still will drop from 190 F. to 170 F. which will shut off the still reflux. The lean oil circulation will continue while the plant slowly cools and approaches ambient temperature. Due to good insulation in the plant, gasoline is still produced for approximately one hour after the heater goes down as the heat is dissipated slowly. The reverse is true when, as the oil temperature goes up automatically, the absorbers are placed in service, and absorbed gasoline and reflux are put back to the still.

The steam generator is shown in Figure 2. The vessel is a vertical heat exchanger with the hot rich oil in the tubes and the water on the shell side. The generator is rated at 2 million Btu per hour and converts 200 gallons of water per hour to 140# steam. The water level is maintained by a liquid level controller and the steam pressure is controlled by the oil heater temperature. A controller on the top temperature of the still shuts off the still reflux on low temperature from loss of oil heater or steam generator. Feed water pumps for the steam generator are electric with automatic pnuematic standby. Condensate from the still trays and gasoline accumulator is used for feed to the steam generator and is supplemented with several barrels daily of fresh water make-up. The make-up water is softened in a zeolite treater and the total feed is cleaned and treated. The steam generator is manually blown down once per day to maintain the total dissolved solids at a maximum concentration of 3,500 ppm.

The gasoline accumulator has a liquid level controller for maintaining a constant liquid level. Failure of this instrument and rising liquid level will operate a high level alarm which shuts off the heater fuel and bypasses the lean oil around the absorber. The oil circulation will continue through the heater, oil interchangers and still until the plant is put back into operation.

The low pressure lean oil pumps are gas-engine driven. Upon engine failure, the drop in lean oil pressure will start the spare gas engine driven pump automatically. The spare unit is shown in Figure 4. Gas-engine standby rather than electric was used because the gas unit was installed prior to the plant conversion. It has, however, worked out satisfactorily and is dependable if it is maintained properly.

The high pressure lean oil pump is a gas-engine driven triplex plunger pump. Upon failure of this pump, the drop in lean oil pressure actuates a controller which operates gas driven simplex pumps.

Both the compressor and absorption cooling tower water pumps are driven by gas engine prime movers with electric motor standbys actuated by a drop in pump discharge pressure.

The compressor intake and absorber discharge scrubbers are equipped with liquid level controls and high level alarms. Upon failure of either liquid level controller, a high level alarm shuts off heater, compressor and engine fuel.

A horizontal-type compressor compresses field gas to approximately 45# into the low pressure absorption plant. No additional automatic equipment was installed to alleviate an excess amount of gas to the compressor, although there is a standby machine. If the compressor fails, a regulator from the high pressure gas system will admit high pressure gas at about 27# to keep up the plant pressure and to furnish field fuel.

Air is used throughout the plant for instrumentation. The air compressor is normally electrically powered. Standby is on a battery started gas engine actuated by loss of air pressure below a minimum set value. If the standby fails, 60# gas enters the air system so that the plant continues to operate.

An outdoor motor control panel serving the automatic electric standby equipment is centrally located and provides a master switch to kill the electricity in case of fire. Outside signal lights are used to notify the travelling field operator of abnormal operating conditions. An outside red light denotes than any or all of the standby cooling tower, absorption oil or steam generator water pumps are on, or that the still reflux pump is off, or high or low oil temperatures exist in the still. Individual lights inside the panel indicate which equipment is operating. An outside blue light denotes that the plant is down and the heater is shut off either from the electric eye on the heater, or the high level alarm on the gasoline accumulator.

**Plant Cost.** The total cost of the plant modification came to $92,300. A good portion of the electrical and valve replacement cost should be classed as contingent items as much of this cost should have been made under routine maintenance. Foundation costs were high as pilings were required due to the sandy nature of the soil. Also the heater, which was the largest single cost item, was conservatively rated to meet anticipated increased loading.

A breakdown into the major cost items is as follows:

| | |
|---|---|
| Direct Fired Heater | $19,100 |
| Steam Generator | 2,500 |
| Oil Reclaimer & Gas Separator | 1,600 |
| Pumps and Gears | 3,300 |
| Meters | 500 |
| Pipe, Valves & Fittings | 10,850 |
| Controllers & Regulators | 7,000 |
| Piling, Fills & Concrete | 6,500 |
| Electrical Material | 16,000 |
| Electrical Labor | 5,000 |
| Labor for Piping, Insulation, Etc. | 17,950 |
| Miscellaneous | 2,000 |
| Total | $92,300 |

In order to keep the plant operating it would have been necessary to spend $45,000 to replace the boilers. Neglecting the contingent items, an additional sum of $47,300 was spent to change the plant to automatic operation. It will be shown later that the additional sum spent resulted in an attractive investment based on the savings in plant operating costs which accrued.

**Comparison of Plant Operating Cost.** The bulk of the saving in plant operating costs was in operating labor. Under the conventional system one senior mechanic, two maintenance men and four operators operated and maintained the plant. Under the automatic system, the maintenance labor was upgraded and the four operators were eliminated. Anticipated labor savings were estimated at $1,650 per month. A review of the actual labor savings indicated that only $1,250 was realized. This is $400 per month lower than anticipated and was due largely to increased maintenance labor. It is felt that the anticipated savings will eventually be realized as more experience is gained in the operation and maintenance of the unattended plant.

Other savings in operating costs came from decreased use of water and electricity, savings in boiler maintenance and water treating, etc., amounting to $250 per month. Union's share of fuel saved amounted to 1,460 Mcf per month which had a value of $300. Total savings in operating costs, therefore, amounted to $1,800 per month or $21,600 per year.

**Payment and Rate of Return on Investment.** Assuming the $45,000 boiler investment would have been required to continue the operation of the plant, the payout on the additional investment of $47,300 based on the savings gained by unattended operation is as follows:

Simple Payout:
Additional Investment: $47,300
Savings in Operating Cost $21,600/Year

$$\text{Simple Payout: } \frac{\$47,300}{\$21,600} = 2.2 \text{ Years}$$

The rate of return before taxes based on the above ratio of investment to annual savings and on an estimated ten year remaining life is 44 percent per annum.

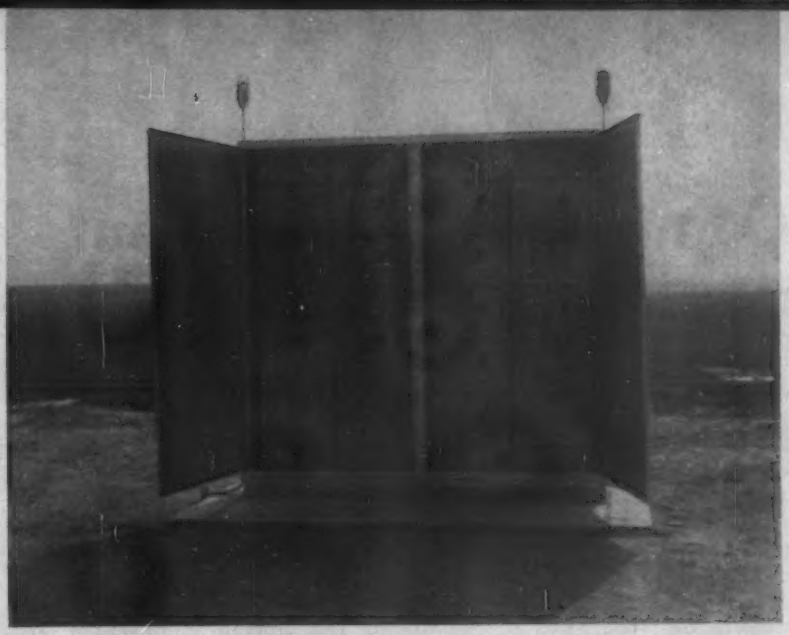

FIGURE 5—Outdoor electrical panel: It provides a master switch to kill the electricity in case of fire.

**Conclusions.** The conversion of a small, conventional absorption plant to automatic, unattended operation was accomplished by installing a direct fired heater, steam generator and automatic controls. The direct fired heater installation offered advantages over steam boilers in (1) the saving of plant labor, (2) ease of operation and maintenance, and (3) better thermal efficiency. Four operators were eliminated from the plant payroll and a reduction in other plant operating costs including water, electricity and fuel was effected. Payout on the additional investment required to effect these savings was 2.2 years which yielded a 44 percent annual rate of return before taxes.

The plant has now been operating unattended for almost three years. The present operation is more consistent and controllable than the conventional plant; call-outs have been cut in half and the plant has experienced a minimum of downtime.

It appears that the system is proven and practical; and studies are being made for larger applications. It is felt that other unattended conversions can be made before it becomes necessary to replace major equipment such as boilers, etc. as they will prolong the economic life of the plant. These conversions should be made while there is still time left in the remaining life of the plant to insure an adequate return on the investment. Also the practical application of unattended operation has now been proven to where it should be considered in the design new plants.


**About the Author**

J. A. Gordon obtained his B.S. degree in engineering from the University of California in 1941 and is a registered professional mechanical engineer of the State of California. He joined Union Oil Co. of Calif. in 1942 and has been actively engaged in gas and gasoline processing problems since that time. At present he is on the engineering staff of Union's Natural Gas and Gasoline department.

# Computer Designs Plants

**Hugo C. Mieth and A. C. Moore**
Tellepsen Construction Company, Houston

IT TAKES a sharp pencil to justify gasoline plants now in a gas field where several companies operate independently. With the time waning when a single company operates from an entire gas field, the trend has been to smaller units. To study such proposed plants, it's now neccessary to make extensive process calculations to cover both oil absorption and low temperature types.

That's where computers can help a lot. Envisioned computer programs, when complete, can design an entire oil absorption gasoline plant with a minimum of input data. Tellepsen Construction Company has recently completed a year's trial on the first step in such a design program—the primary absorber calculation. Using the same medium size digital computer, the remaining steps are now nearing completion.

Computer programs incorporating the tray by tray procedure (resulting in very accurate answers) generally require over an hour of computer time. When rough tray efficiencies are applied to these results, the end answer which is generally used for the process study is still not exact in most cases. The procedure adopted for this program combines a relatively accurate process calculation with a well proven tray efficiency correlation. The end result of this method will approach the same accuracy as the more rigorous method, yet it requires considerably less computer time, which will allow the computer to be used with the remaining series of programs for an entire plant design.

In this absorber calculation program, a lean oil rate may be fixed for a 12 component gas system and a material balance around the oil absorber is calculated in a running time of approximately two minutes. This means that in 20 minutes of machine time, ten lean oil rates may be studied. This will span the desired limits of recovery necessary for an economic study of most proposed plants.

These results are extremely useful for preliminary economic studies. With approximate cost data for gasoline plants based on operating pressure and required lean oil rates, a plant may be estimated in only a few hours of calculation time when utilizing this absorber program.

The mechanics of this program are shown below. The fraction absorbed of any given component, considering the lean oil free of all components in the wet gas is:

$$E_A = \frac{A_E^{N+1} - A_E}{A_E^{N+1} - 1}$$

Edmister's method[1] of averaging the terminal absorption factors is used to arrive at an effective absorption factor for this equation:

$$A_E = [A_N (A_I + 1) + 0.25]^{1/2} - 0.5$$

O'Connell's correlation[2] for over-all plate efficiency in terms of equilibrium constants and physical characteristics of the lean oil is used to determine the theoritical trays for each component. Using these correlations and equations, an initial absorption factor for each component is calculated in the preliminary portion of the program, based on assumed top and bottom plate temperatures, equilibrium constants at these assumed conditions, a starting lean oil rate, a known wet gas rate and composition, and the number of actual trays. The fraction absorbed derived from the preliminary calculation is then used to calculate a new set of terminal absorption factors. This process is generally repeated six times for a 12-component system after which all the $E_A$'s from trial (5) will essentially equal those calculated in trial (6). When the $E_A$ values become equal, then the assumed top and bottom plate temperatures are checked. If these values are correct within the desired accuracy, then the known conditions for the first lean oil rate are available for inspection.

Upon inspection, it will be obvious whether to step up or step down the lean oil rate to reach the proper range of recovery for the key component under consideration. The above process is repeated for each lean oil rate until the desired recovery limits have been covered for the key component under consideration. The program also permits automatic stepping of the lean oil rate so that starting with a maximum lean oil rate, a series of rates may be calculated.

The input to this program consists of 10 data cards which is an indication of the utility of the program. The program proper, including the O'Connell correlation, is read into computer storage in approximately one minute. After the program has been completed on the computer, complete results are punched out including intermediate trials (as well as the final answer) along with all the input conditions.

### NOMENCLATURE

$A_E$ = Effective absorption factor
$A_N$ = Absorption factor for bottom plate
$A_I$ = Absorption factor for top plate
$E_A$ = Absorber efficiency for given component
$N$ = Number of theoretical trays available for component under consideration

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[2] H. E. O'Connell, "Plate Efficiency of Fractionating Columns and Absorbers." Trans. American Institute of Chemical Engineers 42,741 (1946).

### About the Authors

Mieth

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# Slime Control—What You Should Know

**It takes a combination of science and art to keep slime under control in cooling towers, but it can be done effectively and economically.**

**M. C. Forbes**
Aquatrol, Incorporated, Houston

DESPITE LONG RESEARCH, the problem of slime control is one of the most complicated of problems facing the operator of a cooling water system. This is true because in addition to the usual laws of chemistry, he must cope with the laws governing the control of living beings. Most slime deposits can be controlled satisfactorily and economically by the correct application of toxic chemicals. There is a strong analogy between an open cooling water system and the blood stream of a human being having an open wound. Not only are all of the conditions necessary for microbiological life present, but there is an ever present source of fresh infection where the cooling water is exposed to the air in the cooling tower. Besides being a source of infection, the cooling tower also is one of the sources of food for the microbiological population as it scrubs dust and airborne debris from the air in the cooling process. Once the infection has taken place, the circulating water serves as a transportation system for the "bugs" to all parts of the system. When they are fixed in one location, the cooling water delivers food to them and carries away their toxic waste products.

The growth rates of micro-organisms in cooling systems are even higher than in their natural habitats, for here they are protected from many of their natural enemies such as fish and insects.

**What's the Damage.** The presence of large quantities of slime in a cooling system is very unsightly in the exposed parts of the system and not only giving evidence of poor equipment maintenance and housekeeping, but they are the source of considerable economic losses. Perhaps the largest single cost that can be laid to the door of slime deposits is the reduction of system capacity by restriction of cooling water flow and by interference with heat transfer. There are additional losses when microbiological deposits must be removed. Equipment cleaning costs must also include lost production and damage to the equipment that occurs every time the equipment is cleaned.

Also, there are many cases where slime deposits do actual damage to the structure of the system directly or indirectly. Some of the lower forms of life, specifically the fungi, are very destructive to the wood in the cooling system. Metal structures can be damaged by slime byproducts that lower the pH or contain corrosive compounds such as hydrogen sulfide. Colonies of micro-organisms living on a metal surface act as semipermeable membranes which contribute to the formation of oxygen concentration cells. In the case of the so-called "iron bacteria" of the Crenothrix and Leptothrix groups, the bacteria do not attack the metal directly but they ingest soluble iron salts and excrete insoluble iron compounds. This action causes the equilibrium to shift in the direction of further corrosion to supply more Fe ions.

Most microbiological forms can contribute to the formation of scale by acting as an adhesive to bind oil and debris to pipes and heat exchange surfaces. Algae contributes to scale formation by ingesting carbon dioxide which causes the bicarbonate-carbonate equilibrium to shift more toward the carbonate side thus aiding in the precipitation of calcium carbonate.

**How to Spot It.** There exists an extremely large number of micro-organisms which can infect a cooling system. The science of identifying and classifying them is very complex and is so far from actual cooling tower operation that it is of little practical interest to the operator of a cooling tower. But microbiological organisms can be divided into four large general classes on the basis of their effect on the cooling tower.

First, and usually the most obvious, are the algae or the green chlorophyl containing organisms that are present to some extent in nearly all cooling towers at all times. Second, are the fungi or molds that attack the wooden structures of the cooling tower. They are generally not visible to the naked eye but can be identified in the field by their effect on the cooling tower wood in making it lose its strength, usually from the inside out. Next are the slime formers which are bacteria. All bacteria have a slimy outer coat but some (called the capsulated or mucoid forms) are especially noted for growing together in large slimy colonies. And fourth, are the special bacterial forms that are of interest because of some unusual property that makes them outstandingly different from the rest of the group. An example of these special bacteria would

## SLIME GROWTH AND HOW IT'S COUNTED

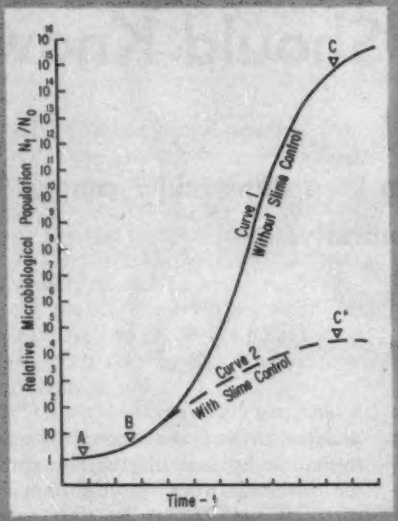



**Figure 1**

The extremely rapid growth of microbiological colonies is one of the reasons why they can be so troublesome in cooling systems.

Under ideal conditions of unlimited food supply, low death rates and good waste disposal, living beings (people as well as microbes) grow according to the equation

$$\frac{dN}{dt} = aN \qquad (1)$$

Where N is the number of organisms present time $t$ and $a$ is a system constant. But ideal conditions never exist for long because sooner or later limitations in food supply or waste disposal cause death rate to equal the birth rate causing the population to become static so that the equation which expresses the growth rate in a dynamic system more realistically is

$$\frac{dN}{dt} = aN\frac{(K-N)}{(K)} \qquad (2)$$

Where $N$, $t$ and $a$ are the same as in Equation (1), and $K$ is the final equilibrium popuation. When Equation (2) is solved for $N$, it yields the following equation:

$$N_t = \frac{K}{1+e^{bcat}} \qquad (3)$$

$N_t$ is the population at time t. When Equation (3) is plotted, the curves in Figure 1 result. $N_o$ is the population at $t = 0$.

Curve 1 shows the growth pattern in a normal system. When unfavorable conditions such as the presence of slime control agents exist, the final equilibrium population $K$ is lowered giving a curve similar to No. 2 in Figure 1. This is important to cooling system operators because a system showing practically no change in microbiological population from time $A$ to time $B$ could have an explosive expansion of microbiological population (to point $C$) and still be consistant with the growth pattern of the system. Likewise, a cooling system having the same points $A$ and $B$ could be held to point $C'$ by the proper selection of slime control measures.

**Counts.** The concentration of microbiological organisms in the water can be estimated by any of several accepted methods. Large organisms such as algae can be estimated by mechanical concentration using the Sedwgick-Rafter technique. A liter or more water is filtered through clean sand in a special filter and the entrapped organisms are then washed into a volumetric flask and diluted to 100 ml. after which the concentrated organisms are sampled and counted in a special cell. The resulting count is multiplied by the concentration factor. Some organisms are best estimated by culturing on agar plates following serial dilution. Every spot on the agar plate is assumed to have resulted from a single organism in the diluted sample.

Recently, a combination of mechanical concentration and culturing has been developed that has some of the better features of each method. In this procedure, water is filtered through a special filter paper which is then used as the culture media.

Direct counts can frequently be made using a phase microscope.

Indirect measurement of bacterial populations can be made using some property of their waste products such as gas formation, transformation of dyes due to pH or an oxidation reduction reaction, or by reaction with salts to form visible precipitates as is the case when hydrogen sulfide from *B.* desulfuricans reacts with lead salts to form black lead sulfide.

In spite of the accuracy and wide range of available test methods, they are generally not reliable in measuring the total microbiological population in a system because those in the fluid phase are only a part of the total population. Such tests cannot reliably show the extent of immobile colonies. In fact, it is not unusual to lower the total population of microorganisms in a cooling system by chemical treatment and then to find that the count in the fluid phase has gone up instead of down because of the dispersion of formerly immobile colonies.

The most reliable measure of microbiological fouling of equipment is the observation of the cooling system by an experienced operator.

be the *B.* desulfuricans which eat $SO_4$ ions and excrete $H_2S$. The $H_2S$ which is formed may cause or intensify corrosion in the system and it may lower to the vanishing point the effectiveness of chlorine for their control or chromate ions used for corrosion inhibition.

**How to Control It.** The main factors that must be considered in selecting slime control agents are their effectiveness, costs, toxicity (to the slime growths and to higher animals), effect on the equipment and ease of application. No one material has been found that will meet these requirements consistently under all conditions.

**Treatments.** Over the years, many types of chemical treatment for slime control have been developed. They can be generally classed under seven basic headings. In addition, there are compounded formulas containing mixtures of these materials.

First, are the salts of the heavy metals such as copper, mercury, silver, tin, and arsenic. Used alone, these metal salts are generally unsatisfactory since in cooling systems, they have limited solubility and they are toxic to higher animals. They are effective even in concentrations of a few ppm and are relatively low in cost. With some sacrifice in economy, these materials can be modified to overcome the solubility limitations by using them in a mixture with organic complexing agents. Examples of this can be found in copper-citric acid mixtures or silver-amine complexes.

Metallo-organic compounds also can overcome the solubility barrier but at even higher costs. Examples of these are copper-pentachlorophenate, mercury pyridyl acetate, cunimene (copper magnesium dehydroabietyl ammine 8 hydroxy quinolinium 2 ethyl hexoate) and tributyltin oxide.

The chlorinated phenols and their salts are very effective against a wide range of microbiological organisms at concentrations of 30 to 200 ppm.

The quaternary ammonium compounds $RC_5H_6NX$ (where $R$ is a large organic radical and $X$ is a soluble anion such as chloride or acetate) have been found to be effective in controlling many bacterial forms but they are expensive and somewhat selective in their action. Some quaternary ammonium compounds are useful also for their detergent properties where foaming can be tolerated.

These materials are sometimes inactivated by adsorbents, high hardness and sulfate ions.

The most widely used materials are the halogens, especially chlorine.

Bromine is gaining wider acceptance in some parts of the country because it is only slightly less effective than chlorine and is much less sensitive to reducing agents. The fact that it costs approximately twice as much as chlorine, limits its use to some extent, but in some cases, it actually costs less per day than chlorine.

Iodine is so expensive that it has little or no commercial usage.

There are applications where materials were introduced into the cooling system that release halogens on dilution. An example of an inorganic compound of this type is calcium or sodium hypochlorite and an example of an organic halogen releasing compound will be debromodimethyl hydantoin.

The halogens and halogen releasing compounds cannot be used in the presence of reducing agents such as unsaturated hydrocarbons or hydrogen sulfide that may leak from the process into the cooling system.

There is a wide range of special compounds that are useful in limited or unusual conditions. Carbon black has been used effectively to treat reservoirs, to kill large algae growths or "blooms" by simply cutting off the available sunlight. Potassium permanganate and other oxidants are very toxic to microbiological growths when they are used in high concentrations. There are numerous records of their use in cooling systems. The ineffectiveness of oxidants in general is attested by the luxuriant algae growths in cooling systems containing 500 ppm or more of chromate. Potassium permanganate in dilute solutions probably acts more as a blackout agent from the precipitation of manganese dioxide than as an oxidizing agent.

Many of the herbicides, fungicides, and bacterial control agents useful in agriculture and other specialized fields would have real effectiveness in cooling systems except for their limited solubility in water and their high cost. As these problems are overcome, better slime control agents will be available to cooling system operators.

**Acclimatization.** It has been the experience of cooling tower operators that there is no single known compound which is completely effective at all times in concentrations that are economical and safe for the control of slime forming organisms. This is true because it is believed that when a slime control agent is used in practice, it is never completely effective for it never kills 100 percent of the organisms present in the system. The remaining organisms are on the average more resistant to the toxic material than the population from which they came. Since this genetic selection can be made as often as three times an hour or about 500 generations per week, a single week for these microorganisms would encompass the same number of generations that would take mankind 15,000 years. Thus it is not surprising that some cooling tower operators have reported that they have bred slime strains resistant to various slime control materials. This process is called acclimatization. Fortunately, it does not follow that the organisms resistant to one chemical are resistant to others. When slime growths appear to have become acclimatized to a particular treatment, heavy doses of another chemical should be made for a short while and then the original treatment can be resumed. It is usually found that the original material will again be effective following the shock doses of an alternate treating chemical.

**Economics.** In making economic comparisons of slime control agents, it is normally sufficient to compare the proprietary compounded materials with chlorine. This is true, because chlorine is considered the standard in view of its long term widespread use and its cheapness in terms of cost per pound. While some of the other materials mentioned above will be cheaper than proprietary compounds in terms of cost per pound for the chemicals alone, they more often than not become prohibitive in cost when the technical service necessary to select and control them is added to the treating material cost.

The only reason that the proprietary compounds can compete with chlorine is that they can be added in large dosages whose effect will persist for long periods of time. Chlorine cannot be added in such large dosage without danger of damaging the wooden structures in the system. Chlorine residuals are not so persistant as these compounds which are not oxidizing agents and are not volatile.

Published studies indicate that the experience of various industrial cooling system operators vary over extremely wide ranges due to the great differences in operating conditions. The general range of chlorine costs are \$0.25-\$2.00 per day per thousand gallons of cooling water per minute circulated with a median value of approximately \$1.00 a day per thousand gallons per minute circulated. The range for the compounded chemicals is generally from \$0.10-\$0.50 per day per thousand gallons per minute circulated with a median value of \$0.30 per day per thousand gallons per minute circulated.

**Operating Hints.** One of the problems facing the operator who would select a slime control chemical is finding the optimum material and finding the optimum concentration at which to use it.

**Concentration.** Theoretically, almost any chemical used will be toxic to nearly all types of slime forming organisms at some concentration. When the problems of economics, safety, practicality of application enter into the picture, the selection becomes much more difficult.

It does little good to identify the specific organisms present for various unidentifiable substrains of the same organism can have such a wide range of sensitivity to a given chemical as to make identification and classification useless as a means of selecting the best chemical. Just as the practice of medicine relies heavily on experience and on empirical methods, in controlling pathological organisms, here too these factors weigh heavily.

**Application.** Direct application of concentrated solutions of chemicals with a pack-type sprayer or dipper to exposed colonies of micro-organisms has proved an effective method of controlling stubborn growths in cooling towers, exposed heat exchangers or other accessible locations. In this case, a 10 percent solution of the chemical is applied directly to the slime growth and the excess is allowed to drain into the tower basin.

Where the growths are inaccessible, high concentrations of chemical can be administered at reasonable cost by using "slug" dosage periodically. This is done by raising the residual of the toxicant to a value several times normal for short periods followed by a period of no treatment and then resuming normal dosages. Slug treat-

ment is limited to those chemicals that would not be damaging or unduly toxic in the higher concentrations.

The life of a slug dose may be estimated by the so-called "wash-out" equation:

$$\log \frac{(R_o)}{(R_t)} = \frac{Ft}{2.3V} \qquad (4)$$

Where $R_o$ is the original residual, $R_t$ is the residual at time t, F is the blowdown (including windage) in gallons per minute and t is the time in minutes and $V$ is the volume of the system in gallons. It is usually sufficient to know the time when 50 percent of the slug is gone and the time when the chemical is essentially all washed out of the system. The above equation shows that 50 percent of the chemical has been blown down from the tower $\left(\frac{R_o}{R_t} = 2\right)$ when the blowdown taken from the tower equals to 70 percent of the volume of the water contained in the system. The treatment has been 95 percent washed out $\left(\frac{R_o}{R_t} = 20\right)$ when the total blowdown since the slug was added is equal to three times the volume of the water in the system.

Even when the proper concentration of chemical is added to a cooling system, there are some factors that can prevent it from being completely effective. Some of the toxicants are made ineffective by reaction with reducing agents (i.e., the halogens). Others such as some of the quaternary ammonium salts are sensitive to the presence of calcium and sulfate ions. Silver and some of the other heavy metals are inactivated by proteinaceous compounds and other naturally occurring nitrogen bases.

Many of these chemicals are adsorbed by suspended solids. It has even been noted that the suspended solids formed when large quantities of immobile slime colonies are dispersed, the dead bodies of the microorganisms adsorb the toxicant and prevent its further effectiveness.

**Thickness Effects.** The thickness of the slime deposit is a factor of major importance in slime control since the lower layers of the deposit can only be reached by diffusion of the toxic chemical through the outer layers of the deposit. This diffusion follows the general equation.

$$\frac{C_o}{C_t} = Ae^{bt} \qquad (5)$$

Where $C_o$ is the concentration of the killing material in the solution, and $C_t$ is its concentration at depth $t$ in the deposit. $A$ and $b$ are system constants. The equation tells us that the cooling system operator who is getting a minimum killing dose to diffuse to the bottom of a deposit of thickness t, by maintaining ten times the minimum residual in the system would have to carry 100 times the minimum killing dose in the cooling water should the deposit be twice as thick.

Recognition of this fact has lead to many experiments using surface active agents in an effort to increase the diffusion rate of the toxic material through the deposit. But it has now been proved that unless the surfactant is a sufficiently powerful detergent to cause the outer layers of the deposit to slough off and thus reduce its thickness, they are of no value. The diffusion of a soluble salt from a solution into a water saturated semi-permeable solid is not considered to be limited by surface forces.

When the slime is too thick for penetration with reasonable concentrations of toxic chemicals, the deposits must be removed before satisfactory chemical control can be established.

Chemical removal with inhibited acid is usually effective even though the slime deposits themselves are not acid soluble. Acid attack of the scale which almost always accompanied the slime or a slight solution of the supporting metal is usually sufficient to loosen and disperse the slime deposits.

Mechanical cleaning with hand tools and scrapers or with air turbines is effectively used by many people. Where the deposit has not been allowed to attach itself too firmly, it frequently can be dislodged by simply backflowing the unit. This procedure is often carried out without removing the equipment from service.

A novel and effective method of removing heavy or stubborn deposits has been developed in which sand and air from a conventional sandblast unit is injected into the backflow. This has been reportedly used with success on units without removing them from service. This procedure has been used as a regular cleaning procedure on some pieces of equipment for as long as five years with little or no evidence of damage due to abrasion.

Regardless of the method of slime removal, care should be taken to see that such large quantities of slime are not removed at one time that the equipment is plugged. When a badly fouled system is being treated for the first time, this problem can be very serious.

**Seasonal Treating.** Traditionally, slime control is considered a seasonal problem possibly because the visible parts of the system show less algae growth during the colder, darker months. Many forms of slime do not show this seasonal pattern. It is probably true that seasonal forms of slime are harder to kill during periods of lower growth rate but in spite of this, the relative effectiveness of slime control is believed to be greater during the dormant period because the regrowth rate is reduced even more than the effectiveness of the toxic chemicals is reduced during this period.

In spite of the great body of technical knowledge on the subject of control of micro-organisms in industrial cooling systems, this subject still has much of the characteristics of an art. The experience of most operators is that this science-art can be applied effectively and economically wherever it is necessary. # #

**About the Author**

M. C. Forbes has been president of Aquatrol, Inc., in Houston since 1949. He also serves the company as technical director. Forbes previously was water engineer for Celanese Corp. of America at Bishop, Texas. Before that he was research chemist with Pan American Refining Corp. at Texas City. He is a graduate in industrial chemistry from the University of Kentucky and holds a M.S. degree in chemistry from Ohio State University. Forbes is a member of ACS and Water Works Association.

# Are You Over-Lubricating Engines?

- **It can be just as harmful as under-lubrication.**
- **Phillips has made big maintenance savings by cutting oil consumption.**

**J. E. Mallow**
Phillips Petroleum Company, Bartlesville, Okla.

PHILLIPS HAS CUT maintenance costs on large engines considerably by cutting down on oil consumption. Believing that over-lubrication is a major problem, we took a look first at large engines operating in most of our plants.

In quite a number of instances we found the same oil rates as existed 20 or 30 years ago. Far too many hold to the opinion that "I have used that amount of oil for 20 years, and I see no reason why it should be changed." There still exists that fear of possible under-lubrication and resultant wear. But, like the automotive engine, our large engines have had vast improvements in design and material construction.

**Design Changes.** In practically all cases today the cast iron used in cylinders and pistons is a process iron with a higher Brinell hardness. There is less possibility of cylinders and pistons galling since the process iron contains less free ferrite. Water jackets are designed so that the water is directed to all parts of the cylinder, eliminating the dead spots which formerly existed. The tendency for the cylinders to elongate and become out of round as a result of operating temperatures is therefore reduced. Finish on cylinder bores and pistons has been improved and in addition we have oil cooled pistons.

In the past, too, it was not uncommon to find piston rings one inch wide or wider. Irregularities on the face of the ring or cylinder bore prevented full contact of the ring on the cylinder wall. Firing pressures behind the wide rings, however, imposed extreme pressure at points where there was only a small area of the ring in contact with the cylinder wall. In most instances today we use narrow rings which reduce blowby. Light testing of rings at the factory has, in general, become a common practice which insures us a perfectly round ring to fit the cylinder.

Ring design and materials have also been improved considerably so that we can now secure rings to handle most any situation we encounter. Faces of rings are also coated with materials which hold lubrication and carry the rings and cylinders through critical periods.

Neither should we overlook the vast improvements which have been made in the quality of our lubricating oils. In spite of all of these improvements, however, which are available to us today, we are still inclined to be cautious and, therefore, use more oil than is required.

**Over-Lubrication Troubles.** We fail to realize that over-lubrication can often be as costly or even more so than under-lubrication. Why do we have stuck piston rings, carboned ports, fouled spark plugs, burned exhaust and intake valves? The answer, of course, is over-lubrication.

The damage, however, is not confined to the items listed above. When the rings stick, the fire from the ignition of the fuel charge passes by the face of the rings and burns the lubrication from the cylinder walls. We then experience a condition of under-lubrication due to over-lubrication and either excessive cylinder wear, galling, or even cracked cylinders and pistons. Since the rings in this condition cannot perform their function of sealing firing pressures, the power cylinder is prevented from carrying its proportionate share of the load imposed on the engine.

The additional load must then be picked up and handled by other power cylinders of the engine provided, of course, that they are not in the same condition. The added load to these cylinders requires they operate at higher firing pressures and temperatures. The increased pressures and temperatures in time cause detonation, creating pressures in excess of that which the bearings are designed to carry. If this condition is permitted to exist any length of time, we will have bearing failures. This is true in spite of the improvements which have been made in bearings such as precision seats and shells, reduction in babbitt thickness and more satisfactory bonding methods.

In two-cycle engines we find over-lubrication resulting in a build up of carbon in the exhaust and intake ports. In either case, due to restriction, we are unable to secure thorough scavenging of the power cylinder. The restriction in the ports, along with the exhaust gases remaining in the cylinder, prevents us from receiving a full charge o. fresh air, and our fuel air ratio is then unbalanced. The cylinder still receives the same amount of fuel gas with the result we have a mixture which is too rich, it creates more heat but less power and once more we are faced with a weak cylinder which will not carry its share of the load.

On four-cycle engines, in addition to stuck piston rings, carbon formation restricts valve ports and contributes to sluggish operation of valves which again provides us with a weak cylinder.

The detrimental effects of over-lubrication, however, are not confined to the power end of the engine. We find excessive carbon formation in the ports of compressor valves restricting the flow of gas and often contributing

to an early failure of either the valve seat, valve springs, or disc. We also experience compressor rod packing failures due to over-lubrication.

**No Lubrication Needed.** There is one other very important part of the engine where actually there should not be any lubrication whatsoever. Yet from all appearances we try to see that it has ample lubrication. We refer to the block on which the engine is set. Oil allowed to leak on the block soon finds its way underneath the main frame and in a short while we experience movement of the engine. We immediately start tightening the anchor bolt nuts, but by applying normal torque we find we do not stop the movement. To hold the engine firm, the anchor bolt nuts are tightened even tighter until the anchor bolts are broken. Finally, we are forced into a costly job of replacing the anchor bolts and resetting the engine.

**Leaks.** An oil leak should be corrected as soon as it is detected, not only because of the possible damage but also as a matter of safety and good housekeeping. Quite often, we find personnel taking the attitude that it is impossible to eliminate all of the leaks. Yet, in another installation we find personnel who with diligence have mastered the situation with either the same type of engines or even older designs. Actually, then, our problem is not oil leaks but instead personnel who, because of a lack of concern, permit them to exist.

**What's Needed.** For years we have contended that lubrication should be reduced to the minimum necessary to maintain an oil film on the cylinder wall and any in excess of the required minimum only resulted in increased maintenance. In recent years, through the cooperation of our district and plant personnel, we have been making a concerted effort to reduce our oil consumption.

We had been averaging around 3000 bhp hours per gallon of oil used. We set 8000 bhp hours per gallon as a goal we desired to attain. This was to be based on all the oil used in the power and compressor cylinders as well as that added to the crankcase. We were of the opinion that the crankcase changes should not be included. We did not immediately cut our oil feed rates to the 8000 bhp figure. Instead, the amount of oil fed to the cylinders was cut in steps and a week to ten days after each adjustment a cylinder head was pulled to determine if the cylinder walls were operating dry or if lubrication could be further reduced. A small piece of absorbent paper placed on the cylinder wall was used to determine the amount of lubrication remaining on the cylinder wall. We have not reached our goal in all of our installations, but in a majority we are approaching it and in a number we have exceeded it.

**Reduced Costs.** We are also seeing the results in reduced maintenance costs. Previous to the reduction in oil consumption in an installation where we have seven 600 hp two-cycle engines, we found it necessary to replace 78 power piston rings in the overhaul of the seven engines. In this same installation we are now averaging 10,000 bhp hours per gallon and in an overhaul of the same engines it was only necessary to replace 11 rings or less than two rings per engine. Micrometer measurements of the cylinders indicated no more than normal wear

We would not want to leave the impression that we expect a like percentage of reduction in ring replacements on all of our installations. There are, of course, other items which can affect ring life besides over-lubrication.

In other installations of large four-cycle engines we have averaged in excess of 25,000 bhp hours per gallon for several years. The human element did not enter into the amount of oil consumed except in design, selection and assembly of component parts. The engines used only the amount of oil that was permitted to pass by the oil control rings, and we can be quite sure that this amount was in excess of what was actually required. If the amount used, however, had been what operating personnel had considered was required, our bhp hours per gallon would probably have been considerably less than half of the 25,000 bhp hours per gallon that has been attained.

Our oil costs per bhp are now 50 percent less than in previous years. This savings along with a reduction in ring replacements, while not a small amount, will only be a fraction of our future savings due to a reduction in lubrication.

We anticipate we will be able at least to double the length of periods between overhauls and thereby reduce the labor cost by one half. In addition, we are of the opinion we will reduce the amount of cylinder reboring and piston replacements which are surely not minor items of costs. As pointed out, we are also of the opinion we will reduce the amount of bearing replacements.

In reducing our downtime for maintenance we will likewise keep our engines on the line a greater percentage of the time and as a result be able to handle larger volumes of gas over a given period of time.

The question may arise as to just how far we can go in the reduction of our lubrication. Frankly, we as yet do not have the answer. We have come to the conclusion that the possible benefits are so great that we could even afford to damage a few cylinders through under-lubrication in order to find the minimum point of lubrication. We actually consider the reduction in lubrication as a very important phase of our preventive maintenance program. If we can prevent the damage as a result of over-lubrication, then we are preventing future maintenance.

This material was condensed from a presentation before the NGAA, Oklahoma City, January 31, 1958. ##

**About the Author**

**J. E. Mallow** received his B.S. degree in 1932 from North Texas State College at Denton. In 1933 he joined Phillips Petroleum Co. in the Natural Gasoline department. Since that time he has served as operator of engines, plant engine foreman, machine shop inspector, district mechanical maintenance superintendent, and since 1953 as mechanical maintenance superintendent for the Natural Gasoline department.

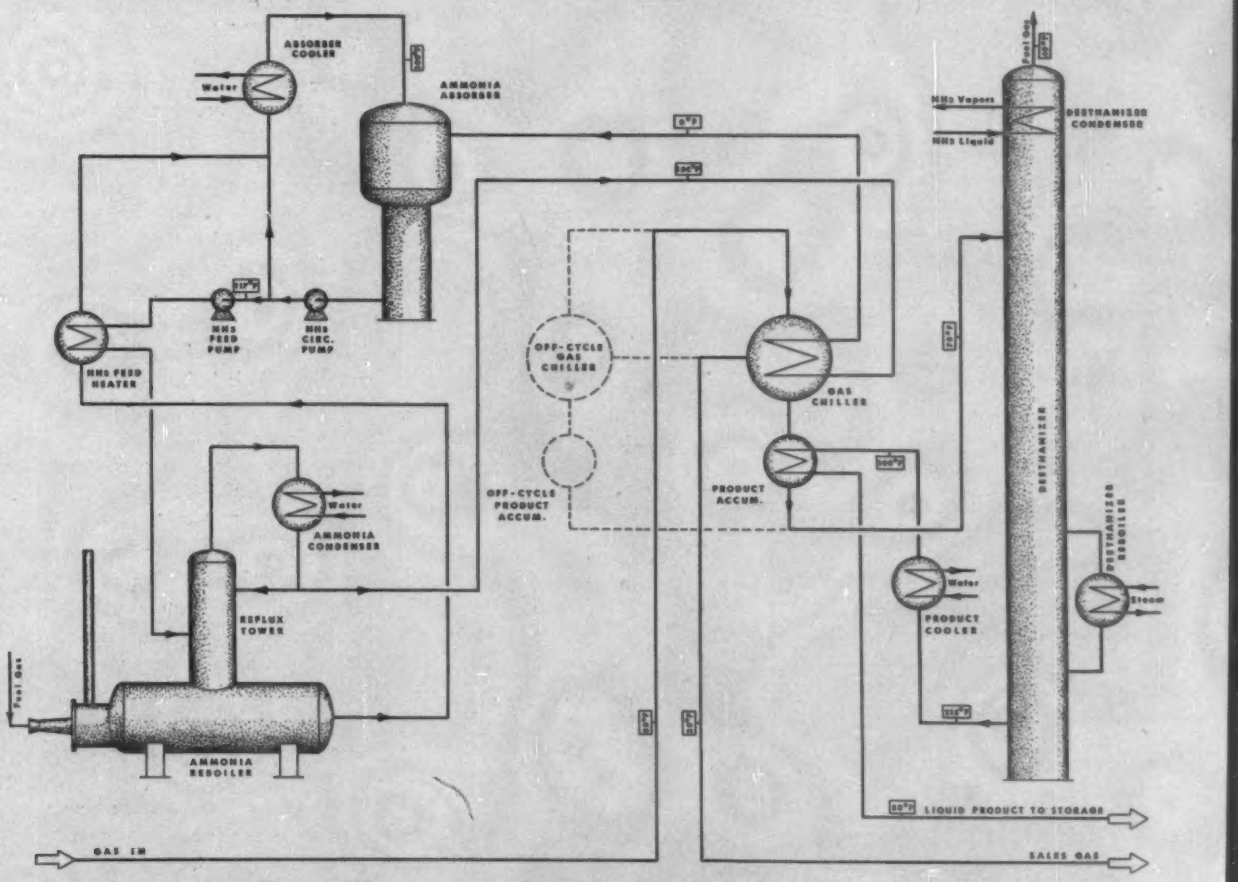
# Wellman Plant Uses Ammonia Cycle

**• Refrigerating gas charge with ammonia absorption cycle eliminates need for dehydrating tail gas later.**

**• Investment was cut by using hydraulic system for driving process pumps and cooling tower fan.**

**J. A. Newsome, Jr.,** Chillgas Corporation, Houston

THIS GAS liquids recovery plant, owned by Llano Grande Corporation, applies refrigeration equipment that not only serves to furnish low temperatures but also dehydrates the residue gas. On stream in July, 1957, the plant is located in Terry County near Wellman, Texas. It is a "package type" plant designed for small gas volume with a maximum of liquid recovery. Being a field unit, a minimum of operating and maintenance per-




**Flow scheme for plant: The two chillers are set on a time-cycle which switches the entering gases from one to the other.**

sonnel was a prime consideration. Automation is so complete that it requires only the partial attendance of two men during a 24 hour period. Instrumentation is adequate but not excessive.

The major components of the plant are a gas compression unit, a package processing unit, a package ammonia refrigeration unit, a deethanizer, and a water cooling tower. Capacity of the plant is 1.5 MMscfd, with a yield of 9,850 gallons per day of 150# RVP product. Propane recovery exceeds 60 percent. Design of the equipment was based on receiving a wet gas at the plant intake with a pressure of 5 pounds per square inch gage and a temperature not to exceed 100 F. The analysis of the feed gas is given below:

| Components | Mol % |
|---|---|
| $N_2$ | 6.04 |
| $CO_2$ | 0.55 |
| $C_1$ | 49.16 |
| $C_2$ | 15.18 |
| $C_3$ | 19.51 |
| $IC_4$ | 2.02 |
| $NC_4$ | 5.16 |
| $IC_5$ | 0.78 |
| $NC_5$ | 0.64 |
| $C_6$ | 0.96 |
| | 100.00 |

After passing through three stages of compression, the gas is delivered to the process unit at a pressure of 700 psig. The compressors, which have intercoolers, are sized for 1.0 MMscfd each. The gas-driven compressor engines perform the following services:

- They furnish energy for compressing the raw gas.
- They furnish energy for driving the oil pumps which power the hydraulic system.

The hydraulic system is the motive power for the drivers of the process pumps and cooling tower fan. The system is closed and has the necessary controls and safety features for economical trouble-free operation. The incorporation of this system into a field installation eliminates the need for electric energy other than for lighting.

In designing the plant, consideration was given to future expansion. The compressors are sized for a peak load of 2.0 MMscfd of gas. The package-type processing equipment is sized to handle 1.5 MMscfd. The entire gas handling capacity can be quickly and easily increased by the addition of packaged processing units. Since the piping and deethanizer are sized to handle up to 3.0 MMscfd, a further increase in capacity can be realized by adding another compressor.

**How the Process Works.** Warm compressed gases enter the off-cycle chiller and melt the hydrates formed on the tubes during the previous cycle. From this chiller the gases go to the second, on-cycle chiller; and here they are chilled to 20 F. The two chillers are set on a time-cycle operational arrangement with the entering gases being switched from one to the other in accordance with the rate of hydrate formation. Cooling of the gases is accomplished by the vaporization of ammonia in the tubes. This ammonia is furnished by the ammonia refrigeration unit. The rate of cooling of the gases by the ammonia is set by the same cycle that controls the entering gases.

Condensed liquids and water drop out in the chillers and are gravity fed to a collecting bottle. This bottle is equipped with a heating coil to partially remove unwanted light fractions and return them to the sales gas stream. The liquids are withdrawn from the collecting drum at a temperature of 70 F. for feed stock to the deethanizer. The deethanizer is of conventional design with a refrigerant-cooled condenser. After leaving the deethanizer, the liquid is cooled and placed in storage tanks. Storage tankage is provided for three and one-half days' liquid production.

The tail gases from the chiller are used to cool the liquid ammonia feed to the chiller. The tail gases, which have been dehydrated and adjusted to pipe line specifications, now enter the sales gas pipe line at a pressure between 600 and 650 psig.

The refrigeration equipment consists of an ammonia absorption unit of 50 tons capacity. This application of refrigeration equipment is unique in that it not only serves as a means of furnishing the low temperatures required for the removal of hydrocarbon liquids, but in the same operation it dehydrates the gas without the addition of chemicals to the gas stream. This eliminates the need for separate dehydration equipment for the tail gases to meet the pipe line specifications.

The process and refrigeration equipment are arranged respectively into two compact, skid-mounted units. These units are entirely portable and may be transported by the usual truck-trailer method of transportation. Each package is complete with all instrumentation and accessories ready for immediate field hook-up. Compressor foundations were combined with the foundation for the building. This building is "wind and dust tight," suitable for West Texas climatic conditions. For other locations, the compressor equipment would be unitized.

The use of the oil motors in the hydraulic system eliminates the maintenance problems inherent with operating electric motors in the West Texas area. The system is not affected by failure of electric power supply. For this installation, the net investment was less than for a system designed around electrically-driven motors.

The entire plant and gathering system were designed and constructed by the Chillgas Corporation of Houston. ##

**About the Author**

**J. A. Newsome, Jr.**, received his B.S. degree in chemistry from Rice Institute in 1936 and, in 1937, became a research engineer for Humble Oil & Refining Co. From 1942 to 1945 he worked in the Applied Physics Laboratory of Johns Hopkins University and became vice-president of Parks Engineering Co. in 1948. In 1949 Newsome joined Parkersburg Rig & Reel Co., and in 1953 served as president of Gas Processors, Inc. He is now vice-president of Chillgas Corp.

# Natural Gasoline Plant Safety | the Phillips Way

**Here is the safety program that has made the Phillips Petroleum Company's Natural Gasoline department one of the safest in the nation.**

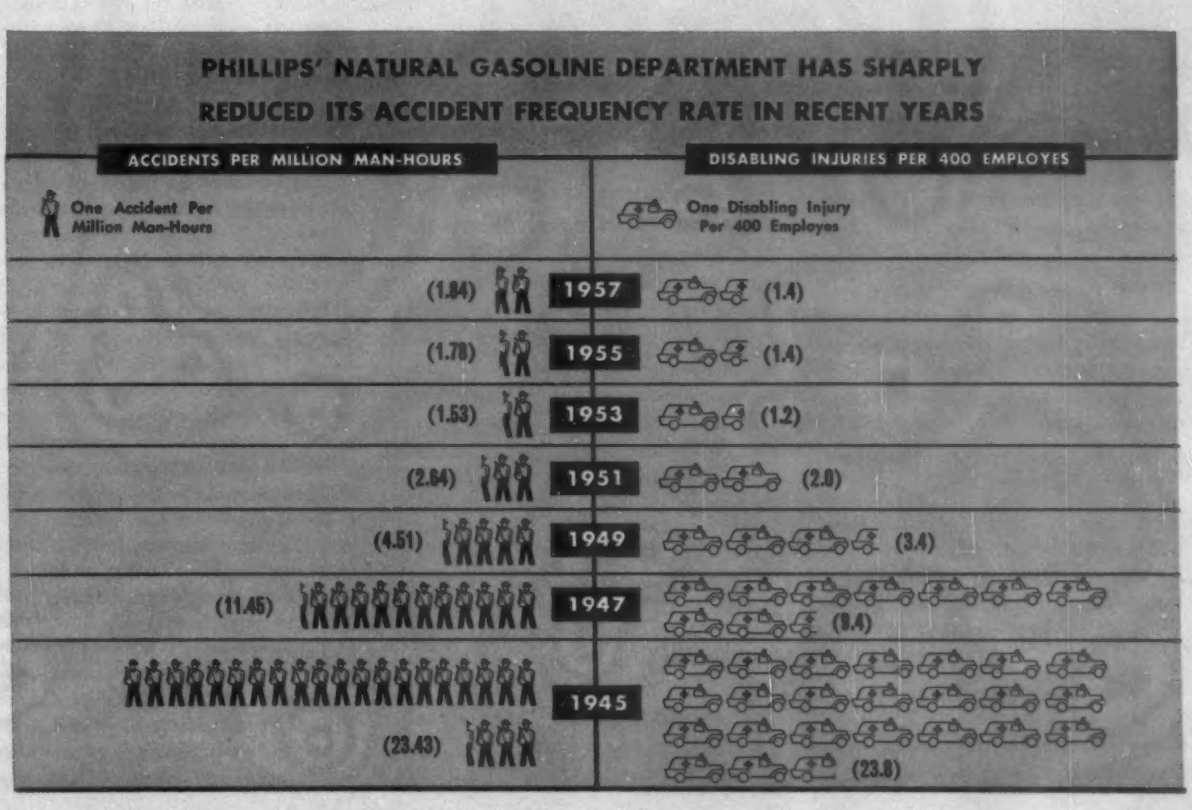
*Disabling injuries: 156.*
*Accident Frequency Rate: 23.43 per million man hours.*
*Number of employes: 2,624.*

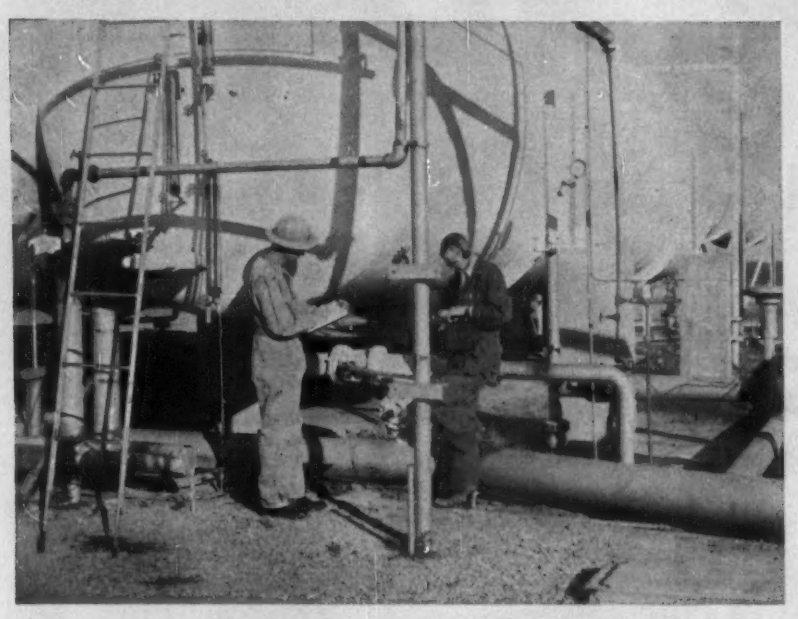
This was the 1945 safety record of Phillips Petroleum Company's natural gasoline department. The rash of eye injuries, sprains and bone breaks—well above the national average—was creating a serious employe morale problem. And good employes were hard to find during that personnel-shy war period.

Realizing strong steps were needed to curb its mounting injury frequency rate, Phillips established the company's first formal natural gasoline department safety program in 1945. Here is what that safety program had accomplished by 1957:

*Disabling Injuries: 9.*
*Accident Frequency Rate: 1.84 per million man hours.*
*Number of Employes: 2,515.*

This was one of the outstanding natural gasoline department safety records in the nation last year—well


PHILLIPS' NATURAL GASOLINE DEPARTMENT HAS SHARPLY REDUCED ITS ACCIDENT FREQUENCY RATE IN RECENT YEARS
ACCIDENTS PER MILLION MAN-HOURS
DISABLING INJURIES PER 400 EMPLOYES
One Accident Per Million Man-Hours
One Disabling Injury Per 400 Employes
(1.84) 1957 (1.4)
(1.78) 1955 (1.4)
(1.53) 1953 (1.2)
(2.64) 1951 (2.0)
(4.51) 1949 (3.4)
(11.45) 1947 (9.4)
1945 (23.43) (23.8)



**Two Phillips employes check for tank defects, using an audio gage. Phillips is one of the few oil companies that includes equipment inspection in its departmental operations.**

below the national average of six-plus injuries per million man-hours worked. In 1956, the API reported that Phillips had the lowest injury frequency rate in the category of large natural gasoline departments—1.27 injuries per million man-hours worked.

The number of disabling injuries per million man-hours is one of the yardsticks used by the industry to measure safety efficiency. If the disabling injury record is good, it usually follows that the number of fires experienced, the number of accidents without injury and the total of minor injuries are at a minimum.

Phillips was able to transform an abnormally high disabling injury rate into the nation's lowest within an 11-year period because of four closely linked factors:

1. **Full support from management,** without which there cannot be an . . .
2. **Adequate safety staff to create . . .**
3. **Proper attitude among supervisors and employes,** whose interest will determine the success or failure of an . . .
4. **Active safety program.**

**Management Support.** Since it was first established, Phillips management has given full support to the Natural Gasoline department's safety program. And every effort is geared to one purpose: "Make each employe responsible for his safety and for the safety of others."

The extent of management support is reflected in the growth of the Natural Gasoline department's safety staff, also in the wide scope of its safety activities and facilities.

**Organize for Safety.** When the program was started in 1945, the staff was composed of six safety engineers. Today there are 13 staff members working in the following areas: Two safety officials administer the department's program, including the Bartlesville office; five safety engineers are in the Panhandle district; four in the Western district; and two in the Oklahoma district.

Phillips' Natural Gasoline department is made up of approximately 2,515 employes in administration, office, maintenance, operations, product loading and laboratories. Facilities include 32 natural gasoline plants (including field lines and gathering systems), 11 booster stations and the Bartlesville office.

**How Field Staff Functions.** Phillips safety engineers work strictly in an administrative capacity. They coordinate the field safety activities and work directly with the district personnel in advising and counseling on the promotion of an over-all safety program.

The safety engineers have five specific functions:

1. Personnel safety
2. Fire prevention, control and extinguishment
3. Vehicle safety
4. Equipment inspection and testing
5. Safety in new plant construction

**Personnel Safety**

1. Organize off-the-job and on-the-job safety meetings.
2. Make available the API six-hour first aid and two-hour safety training course.
3. Handle the indoctrination of new employes.
4. Participate in department and district supervisors meetings.
5. Encourage use of safety equipment and the correction of hazards that develop.
6. Develop and issue safety regulations for the company, contractor, supervisors and foremen. Must see that no work is permitted in hazardous areas without the issuance of a safety, hot work and entry permit.
7. Provide operators with a departmental safety regulations book and make sure employes are familiar with safety features incorporated in the operator's manual.
8. Help administer the safety incentive program.
9. Provide supervisors with employe injury statistics.

**Fire Prevention, Control and Extinguishment**

1. See that new plants are provided with a natural gasoline department standard fire system. In older plants, these systems are revised and improved at the rate of one or two plants a year.
2. Furnish fire fighting, first aid and rescue equipment.
3. Train employes at regular intervals in the control and extinguishment of fires.
4. See that plant process and auxiliary equipment is given consideration for adequate spacing,

**"Phillips equipment and testing program is coordinated by safety personnel, and encompasses all equipment in the gasoline plants with the exception of compressors, pumps, engines and turbines."**

and that manual and automatic shutdown systems are installed to eliminate sources of ignition in the event of equipment failures.

**Vehicle Safety**

1. Organize and participate in vehicle safety meetings.
2. Provide employes with "Behind the Wheel" safe driving manual.
3. Furnish vehicle safety equipment (seat belts, etc.).
4. Provide vehicle accident reports to supervisors.

**Equipment Inspection and Testing.** Phillips is one of the few oil companies that includes equipment inspections in its departmental safety programs. The reasons are twofold: (a). Safety personnel are charged with the responsibility of keeping personnel injuries and fatalities at an absolute minimum and to protect against property loss through fires, explosions and equipment failures. (b). Since employes can be injured due to fires, explosions and equipment failures, it is logical that personnel safety and equipment safety should be combined. The program operates as follows:

1. The inspection and testing program is coordinated by safety personnel and encompasses all equipment in the gasoline plants with the exception of compressors, pumps, engines, boilers, furnaces, and turbines which are handled by the mechanical maintenance section.

However, when mechanical equipment is inspected by test division personnel, their activities are coordinated with the safety section personnel. After a piece of equipment has been inspected, tested and rated, a procedure has been set up whereby the management of the natural gasoline department has to approve or disapprove excess working pressures.

2. Permanent files of all inspection and testing reports made by the test division or gasoline department personnel are kept in the district and department safety directors' files.

3. Annual inspection and inventory of all fire fighting equipment is made by safety personnel.

4. Shutdown systems and safety controls are inspected quarterly by gasoline and general engineering department electricians.

5. When state and insurance company inspections are made of Natural Gasoline department properties, a representative of the safety section accompanies the inspectors.

**Safety in New Plant Construction**

1. An attempt is made to incorporate all safety features in a new plant while the project is still on the drafting board.

2. The actual construction is normally done by outside contractors, or by the general engineering department. Therefore, natural gasoline department regulations are not put into effect until gas has been turned in to the plant.

Items that might be overlooked in the drafting board stage, such as the installation of permanent ladders, walkways and working platforms, are usually added and are in place before actual operation begins.

Installations of new equipment that would cause an operating or personnel hazard after operation begins are changed during the actual construction. This eliminates revamping costs after operations have begun.

3. Approve engineering divisions specifications and prints for final construction from the safety standpoint.

**Develop Proper Attitude.** *"The safety program is nothing but added expense to the company." "Safety slows down production."*

These negative employe reactions are common to every natural gasoline plant operation, no matter how long the safety program has been in existence. Phillips Petroleum Company is no exception.

However, the natural gasoline plant's management took this factor into consideration before the safety program was started. A continuing plan was set up to sell new and old employes alike on the importance of safety, and on the merits of accepting a safety program. Employe interest in safety is constantly encouraged in three ways:

1. During safety meetings, case histories of disabling injuries are discussed to keep employes aware of the individual cost and physical suffering they will have to bear if they are not safety conscious.

2. Employes are reminded regularly of accident costs to the company.

**The assistant safety director of Phillips' Panhandle District, D. H. Hubbard (extreme right), explains safety equipment and devices to new employes.**

3. The natural gasoline department maintains an active safety program which encourages employe participation.

**Phillips' Safety Program.** The Phillips safety program has the same basic features that comprise other natural gasoline department plans—employe indoctrination, safety meetings, training programs, incentive plans and use of bulletin boards.

However, the philosophy used in administering the program keeps employes constantly interested in the department's safety activities. For instance, a monthly safety meeting is held at every natural gasoline plant and unit. Each of these groups elects its own meeting chairman and secretary. To give the employes more confidence when presiding over the meetings, the company sponsors one-day sessions to show the officers how to conduct formal meetings.

This form of employe participation and company cooperation has aided greatly in maintaining employe acceptance of the safety program.

The Phillips safety program is organized as follows:

**Employe Indoctrination.** As soon as he starts to work, the new employe is made fully aware of the safety hazards in natural gasoline operations, and is informed as to the safety precautions he should observe.

Last year, 78 new employes received first aid and safety training in the API training course. This was in addition to the natural gasoline department's one-day employe indoctrination course which includes all aspects of the safety program.

**Safety Meetings.** Phillips puts particular emphasis on its employe safety meetings. Last year, there were 405 on-the-job and off-the-job safety meetings held within the natural gasoline department. During these sessions, 2,160 operating and safety suggestions were offered, of which 1,633 were complied with. Also, 1,819 employes attended 30 vehicle safety meetings during the year.

The natural gasoline department holds three types of safety meetings —the regular monthly employe safety sessions, plus quarterly vehicle and supervisory meetings.

The following topics are covered at the monthly meetings:

1. Operating and safety suggestions.
2. Elimination of hazards.
3. Accidents which have occurred in the group since the last meeting. Also, accidents which have occurred in the department, district, company and industry.
4. Reports from management bringing employes up to date on safety and operating activities.
5. Audio-visual aids are used, such as cutaway models of safety and shutdown equipment.
6. Engineers and process personnel give talks on the safe operation of equipment
7. Blackboard sessions are held in which employes pose emergency problems, then discuss the answers. (Example: What units will be shut down if the 600 pound compressor discharge header ruptures?).
8. Review portions of the API first aid training manual at regular intervals.
9. Review the contents of the safety regulations book at regular intervals.

At the quarterly vehicle safety meetings, employes take part in such activities as:

1. Reports of company vehicle accidents pertaining to district, department and company. Ways to prevent such accidents are discussed.
2. Flannel board presentations and other visual aids are used to stress the importance of vehicle safety.
3. State driving manuals and Phillips' "Behind the Wheel" booklet are reviewed.
4. Safety is discussed by guest speakers, i.e., highway patrolmen and driver training instructors.
5. "Idea" sessions are held in which drivers are asked to make suggestions and recommendations for improving the safety of the vehicles they drive.

Topics covered at the district supervisory meetings include:

1. Present accident costs to the company.
2. Review accidents that occurred during the past quarter and discuss ways in which such accidents can be prevented in the future.
3. Discuss new phases of the company safety program.
4. Present reports on industry fires that have occurred outside the company, including costs and cure as applied to the natural gasoline department.

**Training Programs.** Most of the Natural Gasoline department's training were discussed earlier, i.e., driver training, first aid, employe indoctrination and fire fighting.

Some 432 Natural Gasoline department employes took part in 32 fire combat training courses in 1957. Fire training grounds have been installed at most of the plants throughout the department's operations.

**Incentive Programs.** The Phillips safety incentive plan is divided into four general areas:

1. If operating groups work 12 consecutive months without a disabling injury, they are given a dinner.
2. Safety plaques are awarded by top company officials to plants and units going 1 million or more man-hours without a disabling injury.
3. Company publications give recognition to outstanding safety records.
4. Cash awards are given for unusual safety ideas submitted through the company's suggestion plan.

That Phillips' approach to the problem of natural gasoline plant safety has paid dividends many times over is reflected in the department's achievement award record:

Sixteen operating groups in the department have been awarded 1 million man-hour achievement awards since 1943. Three operating groups have been awarded 2 million man-hour achievement awards. And one operating group has gone 3 million man-hours without a disabling injury.

##

# Better Estimate of Entrainment from Bubble-Cap Trays

**In the region where entrainment affects distillation significantly, the correlations presented here represent experimental data within 20 percent.**

**J. R. Fair and R. L. Matthews**
Monsanto Chemical Company
Dayton, Ohio

THIS EMPIRICAL METHOD estimates entrainment in bubble-cap columns on a theory of "corresponding states" involving conditions relative to flooding. For the first time, design charts are presented for estimating both entrainment and flooding. In the region where entrainment affects distillation efficiency significantly, the correlation is shown to represent experimental data from a variety of sources within ± 20 percent. The correlation is being presented here as a useful and simple design tool, and therefore does not purport to consider specifically every variable known to affect entrainment. Until experimental measurement techniques become more precise, and knowledge of fluid dynamics on bubble trays becomes more advanced, it is doubtful whether a more complex correlation than that presented here is justified.

**Entrainment in bubble tray columns** is defined as the mechanical transport of liquid droplets by the ascending vapor stream. Such entrainment can cause a lowering of mass transfer efficiency through recycle of liquid between trays, and can also lead to trace contamination of the overhead product.

These deleterious effects of entrainment have been recognized for years. However, design procedures have usually been conservative enough to result in an operating condition of low entrainment. The present trend in design is toward the economic optimum, with less emphasis on conservatism. This places renewed interest on the quantitative estimation of entrainment.

**The deleterious effect** of entrainment in distillation operations is usually related to lowered tray efficiency by means of the Colburn equation[5]:

$$E_W = \frac{E_D}{1 + \frac{e\,E_D}{L_{MD}/G_{MD}}} = \frac{E_D}{1 + \frac{e\,E_D}{L_{MD}}} \qquad (1)$$

where $E_W$ is "wet" efficiency (with entrainment) and $E_D$ is "dry" efficiency (without entrainment) on a consistent basis, i.e., local or Murphree efficiency. Other terms of Equation (1) are defined in the Nomenclature section. In theory, when the true flood point is approached, $E_W$ approaches zero. For such a situation, the only term on the right side of Equation (1) which approaches zero is

## Here Is Other Work on Entrainment

A NUMBER of experimental investigations of bubble-cap tray entrainment have been reported in the literature. Most of these investigations were carried out over twenty years ago and did not cover conditions typical of present day operating practice. However, the papers of Chillas and Weir[3], Holbrook and Baker[9], Peavy and Baker[12], and Strang[17] contain some data still of value in modern tower design. The recent papers of Atteridg *et al*[1], Jones and Pyle[10], Brook *et al*[2], and Simkin, Strand, and Olney[16] have done much to provide experimental data covering present day tray types and broad operating conditions. Papers other than those mentioned above have dealt with small columns or have not presented sufficient information to be useful for the purposes of the present work.

Methods for estimating entrainment have been presented by Eduljee[6] and by Simkin, Strand, and Olney.[16] Results from the Eduljee method are extremely sensitive to the degree of cap slot opening and thus are subject to the great inaccuracies involved in estimating slot opening. The Simkin method appears to represent small column entrainment data quite well, but is rather awkward to use and has not been validated for larger column sizes. The present authors feel that another approach to an entrainment correlation is justified at this time.

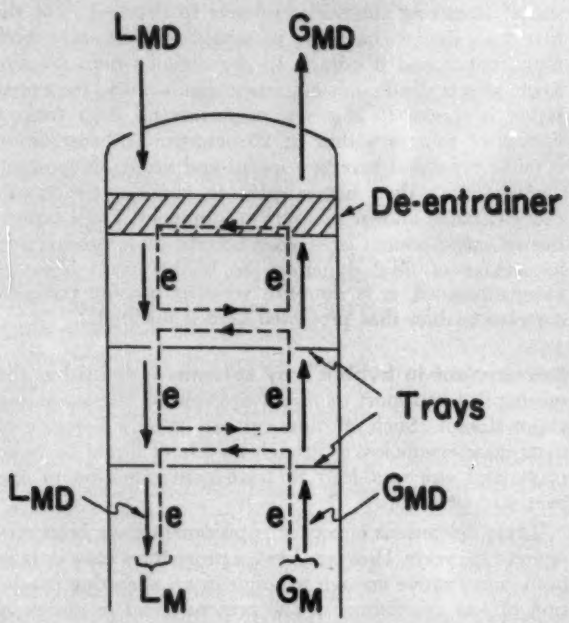



FIGURE 1—Entrainment carries liquid drops up in the vapor stream.

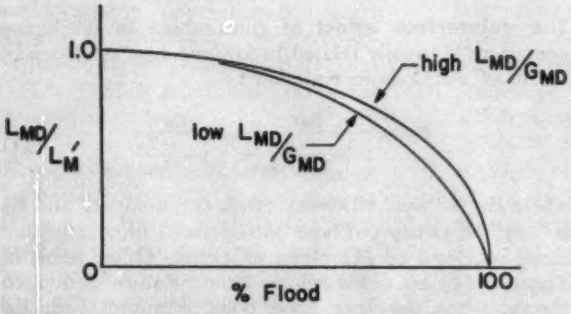



FIGURE 2—A plot of this type is helpful for smoothing experimental data.

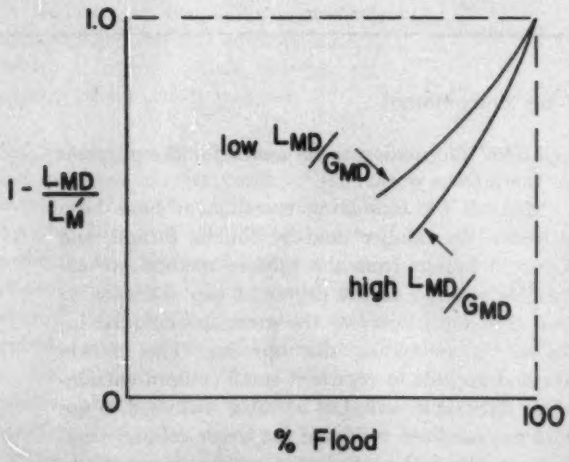



FIGURE 3—Values obtained from a plot like this can be used directly in Equation (1).

$L_{MD}$. If gross liquid and vapor rates are defined as follows:

$$L_{M'} = L_{MD} + e \quad (2)$$

$$G_{M'} = G_{MD} + e \quad (3)$$

then as flooding is approached, $L_{M'}$ approaches e and a downflow persists only according to the local entrainment—de-entrainment pattern. That is, there is no bulk liquid flow through the column and any material flowing to the tray below is entrained back to the tray above. For clarification of the terms used here, reference should be made to Figure 1 and to the Nomenclature section.

If $L_{MD}/L_{M'}$ is plotted against percent of flood, a set of curves of the type shown in Figure 2 can be drawn. The parameter $L_{MD}/G_{MD}$ is introduced to account for variations in experimental data. As would be expected, the ratio of $L_{MD}$ to $L_{M'}$ drops off to zero at the flood point. At points far removed from flooding, $L_{MD} = L_{M'}$, since essentially no entrainment takes place. A plot of the type in Figure 2 is helpful for smoothing experimental data, and also tends to generalize, since process and mechanical design variables are encountered indirectly through the flood point determination.

It is convenient to rearrange curves as shown in Figure 2 to the form shown in Figure 3. The ordinate value (designated by $\psi$) is a *fractional entrainment* based on *gross downflow:*

$$\psi = 1 - \frac{L_{MD}}{L_{M'}} = \frac{L_{M'} - L_{MD}}{L_{M'}}$$

$$= \frac{e}{L_{M'}} = \frac{\text{moles entrained}}{\text{mole gross downflow}} \quad (4)$$

Values obtained from such a plot may be used directly in Equation (1):

$$\frac{E_W}{E_D} = \frac{1}{1 + E_D \frac{e}{L_{MD}}} = \frac{1}{1 + \frac{E_D \psi}{1 - \psi}} \quad (5)$$

A correlating technique of this type may be used directly on performance data for a given system and tray design. In this paper, percent of flooding is defined by:

$$\% \text{ flood} = \frac{G}{G_F} \times 100 \qquad L/G = \text{constant} \quad (6)$$

Thus, if flooding conditions are known, a theory of "corresponding states" may be employed for relating fractional entrainment to fractional flooding. The system and tray design variables normally regarded as affecting entrainment are considered only as they affect the flood point.

**Flooding on bubble-cap trays** may be brought on either by excessive entrainment or by liquid backup in the downcomers. Only entrainment-flooding is of interest in this present work. The approach to flooding of this type is evidenced by a gradual buildup of aerated liquid on the tray (unless, of course, too shallow a liquid seal is provided, in which case "jetting" of liquid droplets can occur). At the flood point this aerated liquid level reaches the tray above and the usual symptoms of increased pressure drop and decreased efficiency are apparent.

The authors' experience in tray design and analysis has

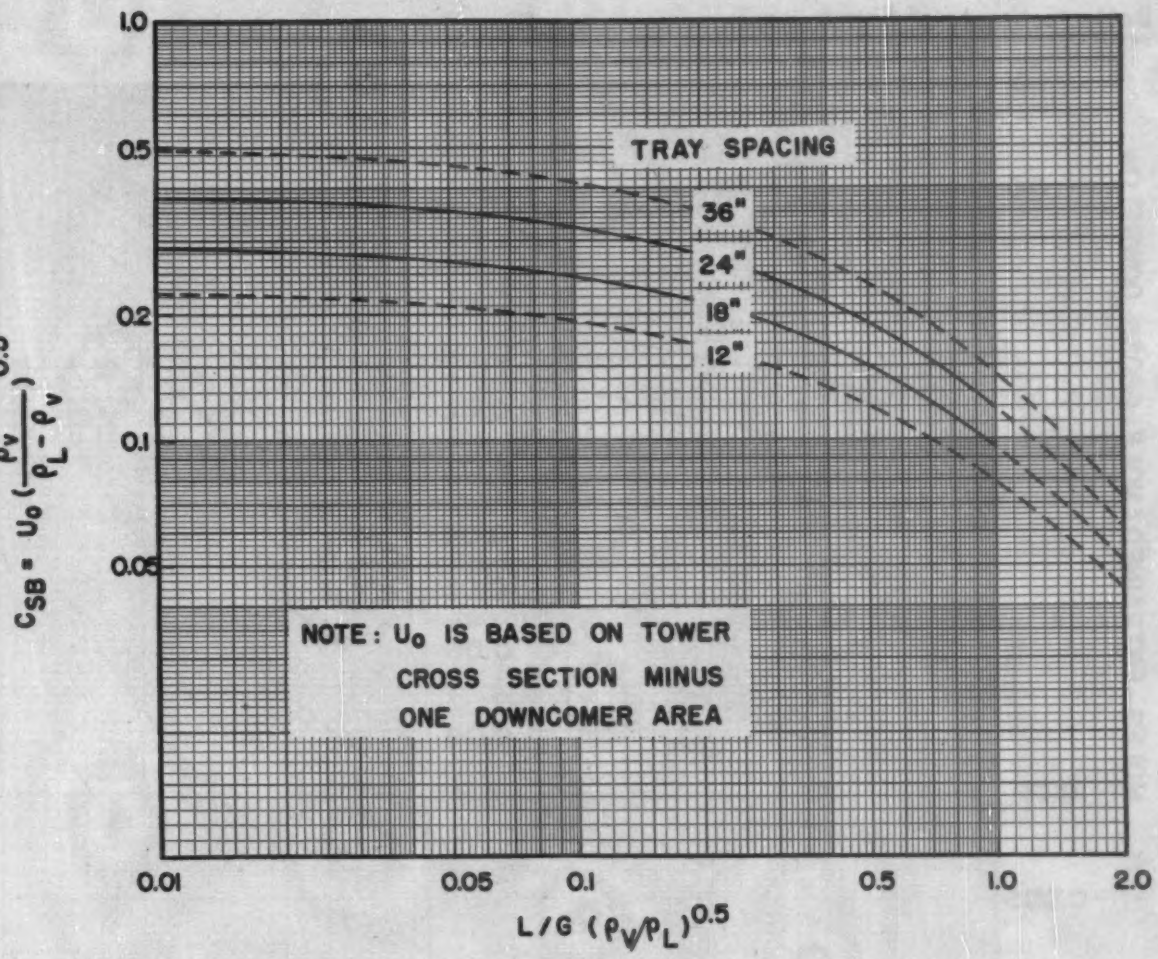



**FIGURE 4—This generalized curve may be used to estimate flooding limits when experimental data are unavailable.**

lead to the adoption of the classical *flow parameter* to correlate bubble tray flooding data.

$$\text{Flow Parameter} = \frac{L}{G}\sqrt{\frac{\rho_T}{\rho_L}} \qquad (7)$$

This is the familiar parameter used in packed column flooding correlations.[14] Although it cannot, of course, represent liquid-vapor flow effects for a complete range of tray designs, it does appear adequate for purposes of entrainment estimation.

For a *capacity parameter*, the familiar Souders-Brown[16] coefficient has been chosen:

$$\text{Capacity Parameter} = C_{SB} = U_o\left[\frac{\rho_T}{\rho_L - \rho_T}\right]^{1/2} \qquad (8)$$

This parameter has some basis in theory, having been derived from a consideration of droplet suspension in a gas stream, and its use is also desirable because of its widespread acceptance in bubble-cap tray design. Other capacity parameters such as that for packed column design[14] and the parameter of Eld[7] appear to possess no advantage over the Souders-Brown parameter for the present case.

Since the entrainment estimation method requires some knowledge of the flooding limit, general curves have been prepared for estimating this limit when experimental data are unavailable. These curves are presented in Figure 4, and have been developed from the data of Jones and Pyle[10], Mayfield *et al*[11], Gerster *et al*[8], Rhys and Minich[13], and Clay *et al*[4], together with unpublished test data. It will be observed that values of the capacity parameter $C_{SB}$ are higher in general than those originally recommended by Souders and Brown. The latter values are not based on a flooding condition, but rather on a conservative condition where entrainment is negligible.

The curves of Figure 4 are general, and are therefore subject to some limitations. These limitations are:

(a) System is low—to non-foaming
(b) Weir height is less than 15 percent of tray spacing
(c) Bubbling area occupies most of area between weirs

Variables other than those shown on Figure 4 appear to

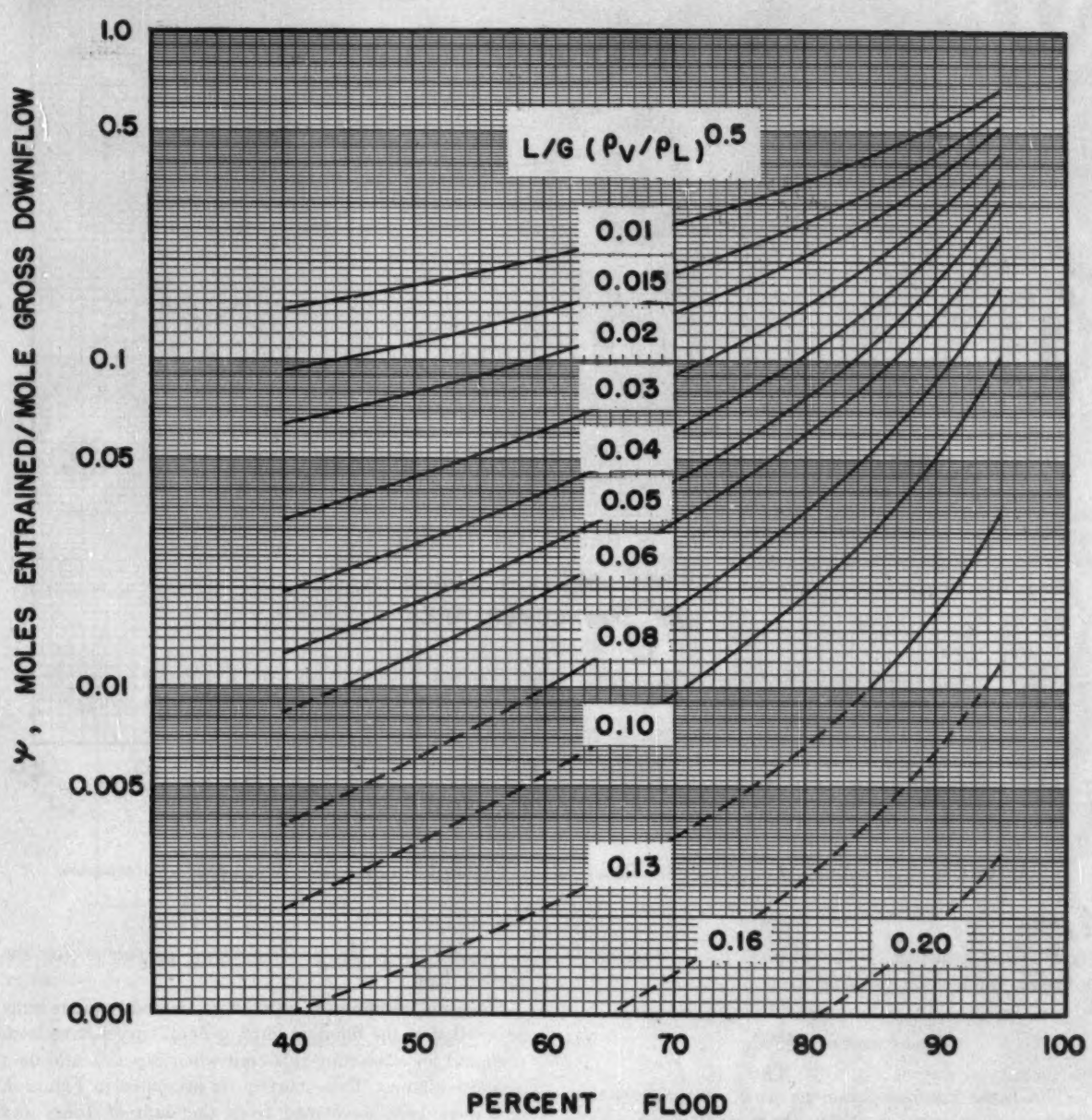



FIGURE 5—This curve should be used to estimate the entrainment for bubble-caps only.

**TABLE 1—Experimental Conditions for Entrainment Measurements**

| Investigator | Atteridg | Brook | Chillas | Holbrook | Jones | Peavy | Simkin | Strang |
|---|---|---|---|---|---|---|---|---|
| Reference | (1) | (2) | (3) | (9) | (10) | (12) | (15) | (17) |
| System | Air-Water | Air-Water<br>Air-DEG<br>Air-Gas Oil | Air-Water | Steam-Brine | HAc-Water | Ethanol-Water | Air-Water | Air-Water |
| Cap Type | Tunnel | Round | Round | Round | Round | Round | Round | Round |
| Tray Spacing, in. | 24 | 19 | 16 | 12 | 18 | 12, 18 | 17.7 | 18, 24 |
| Column Diameter, in. | 18x83 | 15x48 | 20 | 3 | 18 | 18 | 14.8 | 36 |
| No. Data Points* | 33 | — | ** | 3 | 12 | 10 | ** | 9 |
| Liquid Rate, M lbs/hr | 2.7-74.8 | 17.2-43.8 | 4.6-7.2 | 0.11 | 0.55-2.15 | 0.78-2.9 | 8.35 | 0.36 |
| Vapor Rate, M lbs/hr | 13.4-20 | 1.0-4.4 | 1.6-2.5 | 0.21-0.24 | 0.55-2.15 | 0.78-2.9 | 1.23-1.99 | 7.8-13.4 |
| Flow Parameter, $L/G\sqrt{\rho_V/\rho_L}$ | 0.005-0.18 | 0.16-1.25 | 0.077 | 0.011-0.012 | 0.026 | 0.057 | 0.14-0.23 | 0.009-0.0016 |
| Percent Flood | 50-99 | 31-63 | 57-90 | 51-59 | 36-93 | 31-89 | 78-99 | 47-67 |

Notation: * For $\phi > 0.01$. ** Curve given; no data points. DEG = Diethylene Glycol. HAc = Acetic Acid.

**TABLE 2—Comparison of Predicted and Measured Entrainment**

| Investigator | Predicted $0.01 < \phi < 0.10$ No. Pts. | % Dev. | Predicted $\phi > 0.10$ No. Pts. | % Dev. |
|---|---|---|---|---|
| Atteridg[1] | 19 | ±29 | 14 | ±15 |
| Holbrook and Baker[9] | — | — | 3 | ± 6 |
| Jones and Pyle[10] | 5 | ±37 | 8 | ±12 |
| Peavy and Baker[13] | 8 | ±102 | 2 | ±48 |
| Strang[17] | — | — | 9 | ±35 |
| Total | .. | .. | 36 | ±20 |

Note: % Deviation = $\frac{\phi_{measured} - \phi_{predicted}}{\phi_{predicted}} \times 100$

have little effect on the flooding correlation and, thus, on the entrainment correlation.

**The final entrainment correlation** is presented graphically as the design chart, Figure 5. The published source data upon which this chart is based are summarized in Table 1. In addition, the data of Simkin *et al*[15] and Brook *et al*[2], plus some unpublished data have been used in preparing the chart. Figure 5 applies to bubble-cap trays only, although similar curves can be drawn for sieve trays.

The use of the flow parameter $L/G\sqrt{\rho_V/\rho_L}$ in Figure 5 should be noted. Since the quantity of entrainment is a general function of vapor rate, an increase in the liquid/vapor ratio results in a decrease in the fraction of liquid entrained. However, this is not a simple proportionality since effects of liquid rate on contacting action must be considered. These effects include vapor "jetting" at shallow seals, splashing, and frothing action.

**The reliability** of the entrainment correlation has been checked against all applicable published data. Comparisons of chart and published data are presented graphically in Figure 6. Flooding conditions have been obtained from Figure 4. It may be noted that the correlation represents experiment reasonably well, particularly at fractional entrainment ratios greater than 0.10. A tabulation of deviations is presented in Table 2. The data of Chillas and Weir and Simkin *et al* are not included in this table, since no experimental points were given. Basic information of Chillas and Weir was so sketchy as to render the curve on Figure 6 only approximate. The large deviations of the Peavy and Baker data were for 12-inch tray spacing and could have been due to splashing or jetting of liquid.

The effect of deviations at $\psi$ values less than 0.10 is not extreme, and can cause a maximum of 11 percent error in the calculated wet tray efficiency. When absolute values of entrainment are needed for de-entrainer design or pressure drop calculations, it will be noted that the correlation tends to give slightly conservative (high) values, and that greatest percentage deviations are in the region of low absolute entrainment.

For $\psi$ values greater than 0.10, a given percentage error in estimation can result in the same percentage error in efficiency estimation. This is a limiting case, however, as the dry efficiency approaches 100 percent. If, for example, the dry efficiency is 80 percent, the true $\psi$ value 0.15, and the correlation $\psi$ value 0.20; then the true wet efficiency is 70 percent and the value from the correlation 66.5 percent. Here, a 33 percent error in $\psi$ results in a 5 percent error in wet efficiency.

## About Entrainment . . .

- **Entrainment is the mechanical transport of liquid droplets by the ascending vapor stream.**
- **It causes a lowering of transfer efficency through recycle of liquid between the trays.**
- **When data are not availble, a generalized chart may be used to estimate the entrainment flooding limit.**
- **Entrainment under other conditions can be related to the flooding limit.**

## Check this Sample Calculation . . .

In a benzene-toluene fractionator, the following flow conditions are specified:

| | |
|---|---|
| Liquid rate (dry basis) | 200,000 lbs/hr |
| Vapor rate (dry basis) | 240,000 lbs/hr |
| Liquid density | 43.3 lbs/ft³ |
| Vapor density | 0.168 lbs/ft³ |
| Tray spacing | 24 inches |

From a consideration of contacting requirements, a tower 12.0 feet in diameter is selected. For a downflow area of 8.0 ft², the available vapor flow area is 105 ft².

$$U_o = \frac{240{,}000}{(3600)\ (0.168)\ (105)} = 3.78 \text{ ft/sec}$$

$$C_{SB} = 3.78\left[\frac{0.168}{43.3 - 0.17}\right]^{1/2} = 0.236$$

$$\frac{L}{G}\sqrt{\frac{\rho_V}{\rho_L}} = 0.833\left[\frac{0.168}{43.3}\right]^{1/2} = 0.052$$

From Figure 4, $C_{SB}$ flooding = 0.35

Hence, percent flood $= \frac{0.24}{0.35} \times 100 = 69$ percent

From Figure 5, $\psi = 0.04$

Thus, entrainment $= \frac{0.04}{0.96}\ (200{,}000) = 8330$ lbs/hr

If the dry efficiency, $E_D$, is 0.80 (usually referred to as 80 percent), the wet efficiency $E_W$ is, by Equation 5,

$$E_W = \frac{0.80}{1 + \frac{0.80\ (0.04)}{0.96}} = 0.77\ (77\%)$$

## Better Estimate of Entrainment . . .

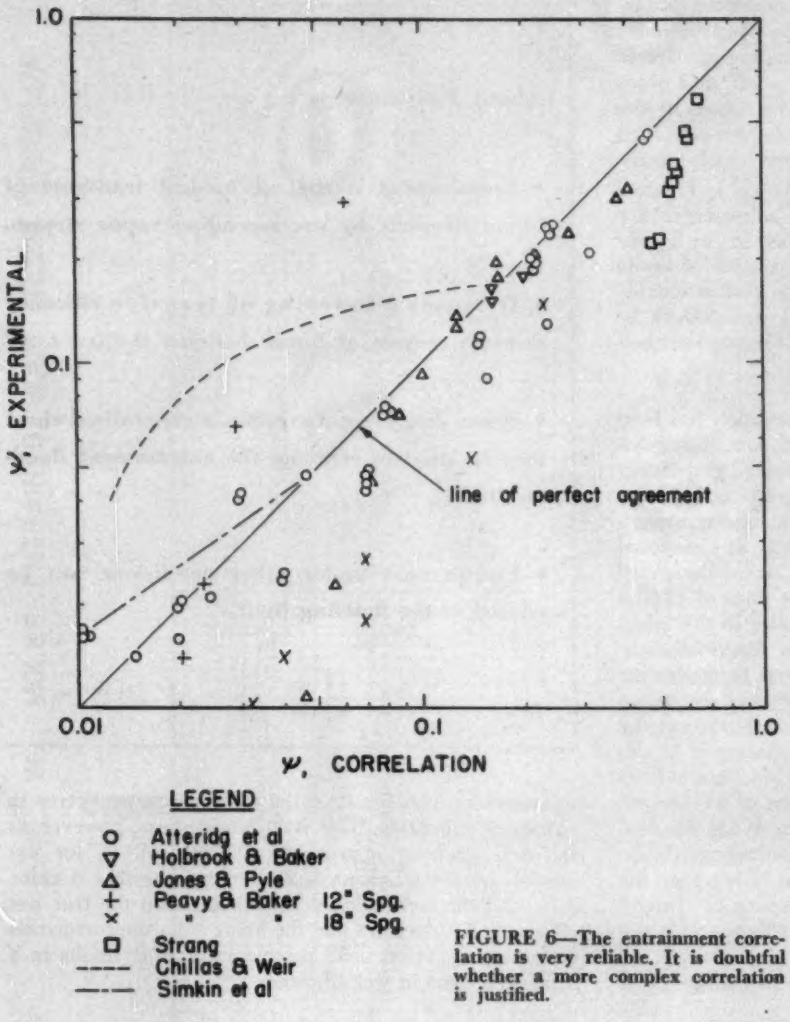



FIGURE 6—The entrainment correlation is very reliable. It is doubtful whether a more complex correlation is justified.

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### NOMENCLATURE

$C_{SB}$ = Souders-Brown capacity coefficient, ft/sec
$e$ = Entrainment rate, lb moles/sec
$E_D$ = Dry tray efficiency (without entrainment), fractional
$E_W$ = Wet tray efficiency (with entrainment), fractional
$G$ = Vapor mass rate, lbs/sec
$G_F$ = Vapor mass rate at flooding, lbs/sec
$G_{M'}$ = Gross vapor molar rate (incl. entrainment), lb-moles/sec
$G_{MD}$ = Vapor molar rate without entrainment, lb-moles/sec
$L$ = Liquid mass rate, lbs/sec
$L_{M'}$ = Gross liquid molar rate (incl. entrainment), lb-moles/sec
$L_{MD}$ = Liquid molar rate without entrainment, lb-moles/sec
$U_o$ = Vapor linear velocity based on tower cross-sectional area minus area of one downcomer, ft/sec
$\varepsilon$ = Entrainment ratio, moles liquid/mole dry vapor
$\rho_V$ = Vapor density, lbs/ft$^3$
$\rho_L$ = Liquid density, lbs/ft$^3$
$\psi$ = Entrainment expressed as fraction of gross downflow

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PART 2

# Design Tips For Your Motor Circuits

**The first part covered conductors, this part explains the design procedure for selecting the required protective devices.**

**J. P. Chamberlain**
Delta Refining Company
Memphis, Tenn.

THE MOTOR BRANCH circuit conductors and the feeder conductors have now been sized. The next step is to size the motor running overcurrent protection, the motor branch circuit protective device and the feeder protective device. Figure 2 shows the essential parts of a typical motor branch circuit. These parts, other than the wire of the branch circuit, are: the branch circuit protective device, the motor disconnect means (under certain conditions) and the motor controller.

### Circuit Protective Device

This device may be a switch and fuses or a circuit breaker.

Under certain conditions, such as in the Type 3 or Type 4 layout (Figure 1, Part 1), this device may be eliminated. In order to do this, the motor branch circuit ahead of the motor protective device must have the same current-carrying capacity as the feeder or, must have at least ⅓ of the current-carrying capacity of the feeder and not be over 25 feet long, and it must be protected from mechanical injury. Also, Section 4343 of the code governing group installation of motors, must be complied with.

The current-carrying capacity of this motor branch circuit protective device must be such as to carry the motor starting current; but yet, not be so large as not to protect the motor branch circuit conductors and the controller against overcurrent due to short circuits or grounds.

The code covering this reads as follows:

**"4342—Rating or Setting for Individual Motors.** The motor-branch-circuit overcurrent device shall be capable of carrying the starting current of the motor. Overcurrent protection shall be considered as being obtained when this overcurrent device has a rating or setting not exceeding the values given in Tables 26 or 27, Chapter 10; provided, that when the overcurrent protection specified in the table is not sufficient for the starting current of the motor, it may be increased, but shall in no case exceed 400 percent of the motor full-load current."[1]

The code's Table 26 gives the maximum setting of the motor branch circuit protective device for motors marked with a code letter while Table 27 gives the same information for motors without code letters. The code letter is a letter stamped in a separate box on the motor nameplate which shows the motor current input with locked rotor.

In the example, as in most instances, the electrical system is designed at the time the motors are purchased. Therefore, the motor code letter is not known. All of the branch circuit protective devices may thus be taken from Table 7, which is a reproduction of the code's Table 27.

As an illustration, we will size the branch circuit protective device for the 100-hp motor shown as motor P-301 of the example. Table 7 shows that for 100-hp, when using a time limit type circuit breaker, the trip can be set as high as 200 percent of the motor's full load current. Table 1 indicates that the full load current of a 100-hp motor is 123 amps at 440 volts. The code, therefore, considers the branch circuit conductors as well as the motor protected against shorts if the circuit breaker has a rating of or less than:

$$123 \text{ Amps} \times 200\% = 246 \text{ Amps}$$

From a practical standpoint, the circuit breaker will be a 200-amp unit, since this is the standard unit supplied by controller manufacturers in their combination motor starters.

Table 2 shows the 125 percent current rating of the 100-hp motor to be 154 amps, which would require three, 3/0 conductors to the motor having a safe current-carrying capacity of 165 amps. However, the circuit breaker which protects these conductors has approximately 120 percent of the current-carrying capacity of the wires. The reason for this is that the motor branch circuit protective device must be large enough not to

**The first part of this series described a number of electrical terms that are used in the article. It also illustrated the design method by using a typical refinery unit's motor circuits consisting of nine motors and one welding machine, duplex receptical. The National Electrical Code pertaining to each part was cited and the branch circuit conductors together with the feeder conductors were sized.**

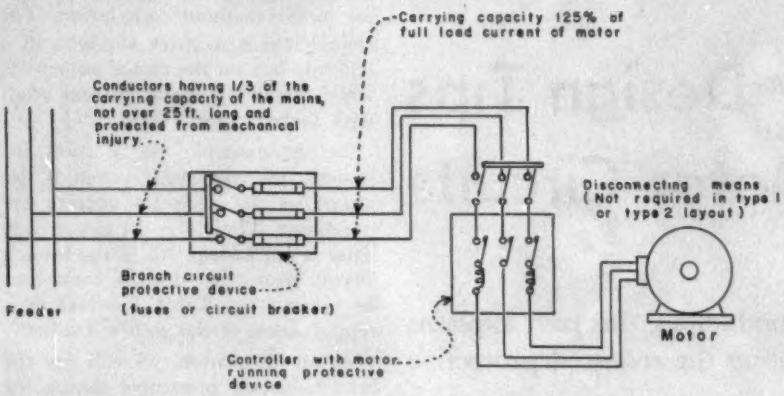
Carrying capacity 125% of full load current of motor
Conductors having 1/3 of the carrying capacity of the mains, not over 25 ft. long and protected from mechanical injury.
Disconnecting means (Not required in type 1 or type 2 layout)
Branch circuit protective device (fuses or circuit breaker)
Feeder
Motor
Controller with motor running protective device

FIGURE 2—A typical motor branch circuit has these essential parts.

open during the initial inrush of starting current. This inrush varies from 150 to 300 percent of the motor full load running current depending on the size and type of motor.

It is evident that the installation of motor conductors having 150-300 percent of the motor running current would be wasteful as the excess copper would serve no useful purpose.

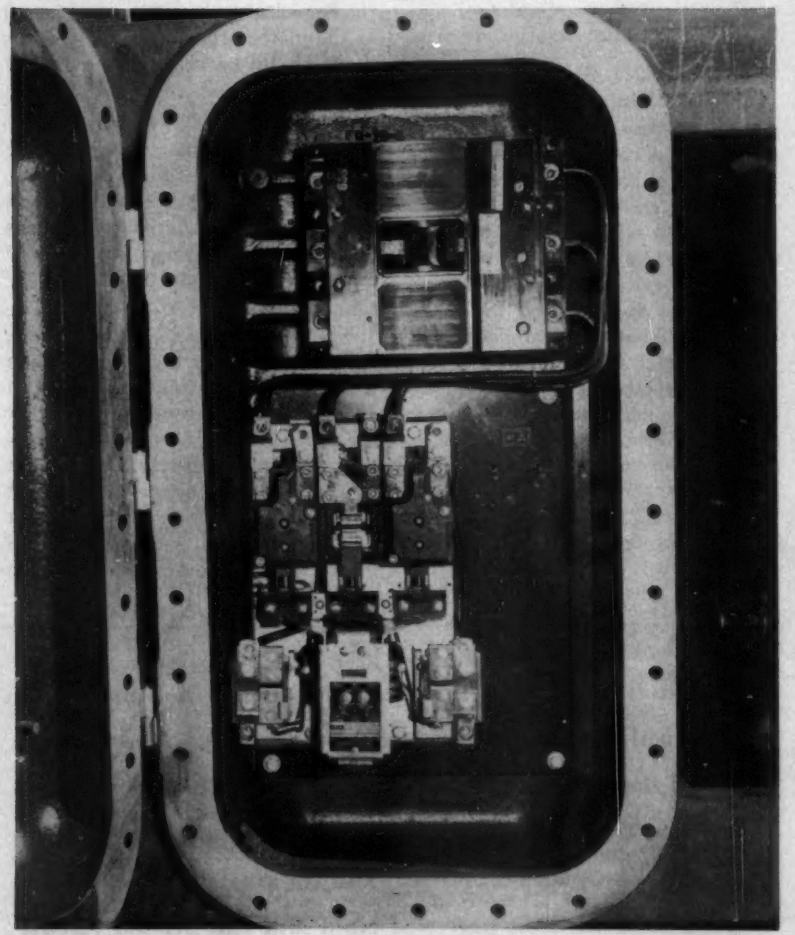

FIGURE 3—The top of this explosion-proof starter box contains the circuit breaker that protects the branch circuit.

Viewing the problem from a practical standpoint, there are three possible causes of excessive current in the conductors between the panelboard and the motor when the motor is running: (1) A short circuit between two of the conductors, (2) a ground on one conductor that forms a short circuit, or (3) an overload on the motor. A short circuit would draw such a large current that the protective device would open immediately even if it were 400 percent of the motor rating. Any excess current, due to motor overloading, must first pass through the motor running protective device at the motor controller causing this device to open the circuit. Therefore, with circuit conductors having a carrying capacity equal to 125 percent of the motor-running current and with the motor-protective device set to operate at the same current, the conductors are fully protected.

### Motor Disconnect Means

The motor disconnect means is a switch or circuit breaker located ahead of both the motor and its controller which is intended as a safety device when working on the motor or its controller.

The code rule covering this installation is as follows:

**"4402-Type.** The disconnect means shall be a motor-circuit switch, rated in horsepower, or a circuit breaker, except as permitted in the following paragraphs: a, b, c, d, or e. Every switch in the motor branch circuit within sight from the controller location shall comply with these requirements."

**"(a) One-Eighth Horsepower or Less.** For stationary motors of ⅛ hp or less, the branch-circuit overcurrent device may serve as the disconnecting means."[1] (Note: Under this exception, if there is another switch in the motor circuit which might be opened in case of trouble, this switch must comply with the main code.)

**"(b) Two Horsepower or less.** For stationary motors rated at 2 horsepower or less and 300 volts or less, the disconnecting means may be a general-use switch having an ampere rating at least twice the full-load current rating of the motor."[1] (A gen-

eral-use switch is a switch which is rated in amperes and is different from a motor circuit switch in that a motor switch is rated in horsepower.)

**"(c) Over Two Horsepower to and Including 50 Horsepower.** The separate disconnecting means required for a motor with a compensator type of controller may be a general-use switch if all of the following provisions are complied with:

1. The motor drives a generator which is provided with over current protection.

2. The compensation (1) is capable of interrupting the stalled-rotor current of the motor, (2) is provided with a no-voltage release, and (3) is provided with running-over current protection not exceeding 125 percent of the motor full-load current rating.

3. Separated fuses or a circuit-breaker rated or set at not more than 150 percent of the motor full-load current, are provided in the motor branch circuit."[1]

**"(d) Exceeding 50 Horsepower.** For stationary motors rated at more than 50 horsepower, the disconnecting means may be a motor-circuit switch also rated in amperes, a general use switch, or an isolating switch."[1] (Note: This switch is not intended to be opened while the motor is running and should be marked "DO NOT OPEN UNDER LOAD.")

**"(e) Portable Motors.** For portable motors, an attachment plug and receptacle may serve as the disconnection means."

In most refinery applications, the above motor disconnect means can be eliminated providing certain conditions as outlined in Sections 4406 or 4407 of the code are met. Essentially these sections say that in Type I or Type II layouts, the motor branch circuit protective device can serve as the disconnect or under certain conditions the controller will serve as both controller and disconnect providing it meets all of the requirements for a controller and is protected by an overcurrent device which opens all ungrounded conductors. If the controller is of a compensator type (auto transformer), a separate disconnect means will be required. The overcurrent device, in order to

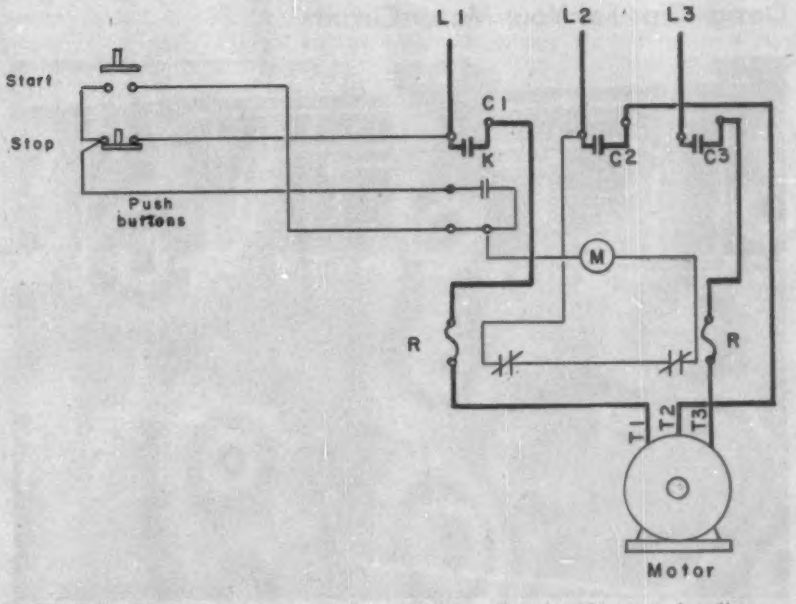


**FIGURE 4—Heavy motor current is shown by heavy lines in this connection diagram of a motor starter.**

**FIGURE 5—The main power distribution panel contains the service circuit breaker.**

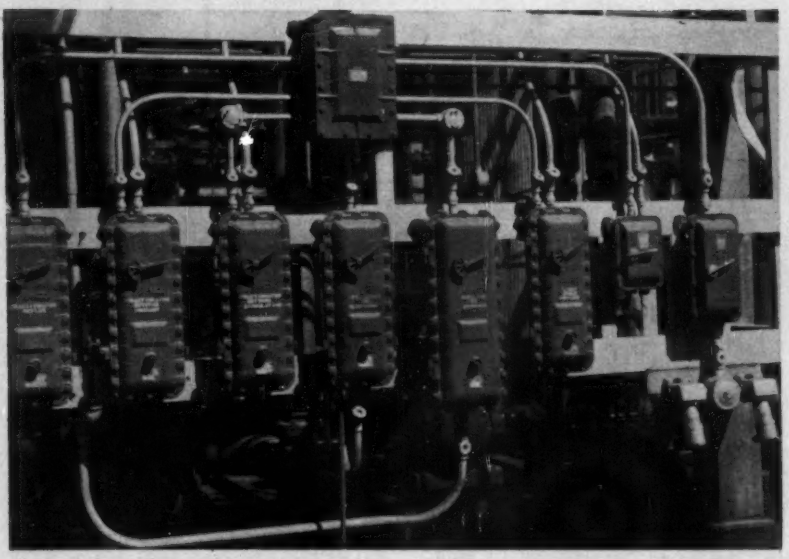

FIGURE 6—A typical branch circuit distribution center. Note the unit names lettered on each branch box.

serve as a disconnect, must be in sight of the controller or else be capable of being locked in the open position.

### Motor Controller

So far as the National Electrical Code is concerned, the term "Controller" includes any switch or device normally used to start and stop a motor. Many engineers, when thinking of a "controller," visualize a device that serves to regulate the speed of a motor as well as to start and stop it. They call a device which merely starts or stops a motor, a "motor starter." In this discussion, the two words will be used interchangeably.

The motor controller, which is in general use in most industrial application, is the line voltage, magnetic type contactor. This starter serves two purposes. First, it provides a means of closing the circuit thereby starting the motor. Secondly, it protects the motor, the motor-control apparatus, and the branch-circuit conductors against excessive heating due to motor overloads. This second feature is the so-called, "motor running protection."

Figure 3 shows the inside of a 100-hp combination motor starter for class 1, group D, explosion-proof installations. Note that the top of this unit contains the 200-amp circuit breaker previously selected, which serves as the branch circuit protective device. The line voltage, magnetic starter, complete with a magnetic closing coil and motor running relays, in two legs of the three phase motor circuit, is located in the bottom of the unit. The cover over the center contacts, in Figure 3, has been removed to show the contacts.

Figure 4, is a sketch showing the connection diagram of this type of motor starter. The heavy lines show the path of the heavy motor current, and the light lines show the path of the current energizing the magnetic closing coil. Figure 4 shows that L1, L2, and L3 are the terminals for the three phase wires from the branch circuit protective device and that each of these circuits continue through C1, C2, and C3, the maintained contacts which are closed by the action of magnetic coil M. From each of the outside contacts C1 and C3, the motor current passes to the motor through the heaters of thermal relay R and on to the motor terminals T1 and T3. The center path is from C2 direct to the terminal T2.

The size or rating of the controller must be such that it can safely start and stop the motor without burning of the contacts. In addition, the controller when used on AC motors shall be capable of interrupting the stalled rotor current of the motor. The code covering the rating of these units require that they be sized in horsepower; therefore, when selecting the starter, merely make certain that it is as large or larger than the motor it is to control and is suitable for the voltage on which it must operate.

Concerning the rating of the motor running protection or size of the heaters for the relays of Figure 3, the code reads as follows:

**"4322—Continuous Duty Motors.** Each continuous duty motor shall be protected against running overcurrent as follows:

**"(a) More than one horsepower.** For a motor rated more than one horsepower, the protection shall be secured by the use of one of the following means:

"(1) A separated overcurrent device which is responsive to motor current. This device shall be rated at not more than 125 percent of the motor full-load current rating for motors marked to have a temperature rise not over 40 C, and at not more than 115 percent for all other types of motors. For other than sealed refrigeration compressor motors this value may be modified as permitted by section 4324." (Section 4324 governs non-standard size or ratings. It says that in these cases the next higher rating can be used but not higher than 140 percent of the full load current rating of 40 C. rise motors.)

"(2) A thermal protector integral with the motor approved for use with the motor which it protects on the basis that it will prevent dangerous overheating of the motor due to overload or failure to start. If the motor current interrupting device is separate from the motor and its control circuit is operated by a protective device integral with the motor, it must be so arranged that the opening of the control circuit will result in interruption of current to the motor.

"(3) For motors larger than 1500 horsepower, a protective device employing embedded temperature detectors which cause current to the motor to be interrupted when the motor attains a temperature rise greater than marked on the nameplate in an ambient of 40 degrees.

**(b) One Horsepower or Less Manually Start.** Any motor of one horse-

power or less which is portable, is manually started and is within sight from the starter location, shall be considered as protected against overcurrent by the overcurrent device protecting the conductors of the branch circuit. This branch circuit over-current device shall not be larger than that specified in Table 20, Chapter 10, except that any such motor may be used at 125 volts or less on a branch circuit protected at 20 amperes. Any such motor which is out of sight from the starter location shall be protected as specified in paragraph C for automatically started motors. Any motor of one horsepower or less which is not portable, shall be protected in accordance with section 4322-C."

Paragraph C is essentially the same as paragraph A, with one exception—if the impedance of the motor windings is sufficient to prevent overheating because of failure to start, the motor may be protected as specified in paragraph b.

From a practical standpoint, when sizing the heaters for the relays, follow the motor starter manufacturer's instructions. Near the magnetic contactor will be a chart giving the correct size of heaters for motors whose full load current capacity is known.

All of the devices and wire, in the example, have been sized with the exception of the feeder circuit breaker. The code covering the rating of this breaker reads as follows:

**"4362. Rating or Setting Motor Load.** A feeder which supplies a specific fixed motor load and consisting of conductor sizes based on section 4314 shall be provided with overcurrent protection which shall not be greater than the largest rating or setting of the branch-circuit protective device, for any motor of the group plus the sum of the full-load currents of the other motors of the group. For large capacity installations, where heavy capacity feeders are installed to provide for future additions or changes, the feeder over current protection may be based on the rated current-carrying capacity of the feeder conductors."[1]

The feeder, overcurrent protection, in the example, will be the sum of the full load currents, from Table 2, plus the difference between the permissible setting of the largest motor, branch circuit protective device and its full load current rating. That is;

433.5 amps plus (246-123 amps) = 556.5 amps.

A feeder circuit breaker rated at 600 amps will be selected since it is the next larger, standard rated unit. This would also be permissible had it not been the next larger standard unit since the feeder wires have a capacity of 640 amps. For adjustable-trip circuit breakers, section 2403 of the code permits a setting of not more than 150 percent of the allowable current-carrying capacity of the conductors.

The main service switch or circuit breaker may be sized as if it were a feeder circuit breaker; that is, sized for the rating of the feeder circuit breaker having the largest motor plus the sum of the full load currents on all the other feeders. This device may be larger, providing the main panelboard conductors can carry the current. In our refinery, the service circuit breaker is set at 4000 amps and is mounted on a 6000-amp frame. In selecting this device, the power company supplying the power must be consulted. Figure 5 shows the main power distribution panel for a typical refinery. Figure 6 shows a typical branch circuit distribution center.

### Installation Hints

When pulling wire in conduit, the code will not permit more than 4-90 degree bends or their equivalent, between pull boxes. It will not permit seal-off, in hazardous areas, more than 18 inches from the arc making device, nor will it permit power conductors to pass in and out of a hazardous area unless there are seal-offs at each end.

When pulling power wiring larger than 200 MCM, it is good practice not to pull the motor control (push-button) conductors in the same conduit, as the larger conductors tend to crush the #14 control wires.

In areas where the motor controller or its push button is not at the motor which it controls, a safety device which will disconnect the motor must be located at the motor. In hazardous areas, the disconnect device may be a lock-out in the control circuit which when opened will allow the magnetic contactor to drop out.

When designing motor power circuits, first tabulate the motor horsepower, the full load current for each from Table 1 and then figure and tabulate the 125 percent values of the full load current. Second, select the size of the motor branch conductors from Table 3 or 4, being sure that the conductors will carry a minimum of 125 percent of the full load rating. Third, size the feeder conductors from Table 3 or 4 using as a minimum, 125 percent of the full load current of the largest motor plus the sum of the full load current of all the other motors. Fourth, select the motor branch circuit protective device, sizing it on information given in Table 7. Fifth, select the motor controller on the basis of motor horsepower and install the proper size overload heaters as directed by the controller manufacturer. Finally, size the feeder protective device, the size of which is the sum of the largest branch circuit protective device plus the full load current of the other motors on the feeder.

**TABLE 7**

**Maximum Rating or Setting of Motor-branch-circuit Protective Devices for Motors Not Marked With a Code Letter Indicating Locked Rotor Kva**

| Type of Motor | PERCENT OF FULL LOAD CURRENT | | |
|---|---|---|---|
| | | Circuit-Breaker Setting | |
| | Fuse-Rating | Instantaneous Type | Time Limit Type |
| Single-phase, all types | 300 | .... | 250 |
| Squirrel-cage & synchronous (full-voltage, resistor & reactor starting) | 300 | .... | 250 |
| **Squirrel-cage & synchronous (autotransformer starting):** | | | |
| Not more than 30 amp | 250 | .... | 200 |
| More than 30 amp | 200 | .... | 200 |
| **High-reactance squirrel-cage:** | | | |
| Not more than 30 amp | 250 | .... | 250 |
| More than 30 amp | 200 | .... | 200 |
| Wound-rotor | 150 | .... | 150 |
| **Direct-current:** | | | |
| Not more than 50 h.p. | 150 | 250 | 150 |
| More than 50 h.p. | 150 | 175 | 150 |

**Note:** This table is a reproduction of Table 27 of Chapter 10 in the National Electrical code.

LITERATURE CITED

[1] 1956 edition of the National Electrical Code.

# A Refining "Hall of Fame"

Next year, 1959, is the one-hundredth anniversary of the beginning of our great oil industry. And to commemorate this occasion, PETROLEUM REFINER will dedicate a major section of its January, 1959, issue to the remarkable development made by the petroleum refining industry in the 100 years since the Drake discovery well.

Among the special features of the Oil Centennial Issue will be a "Hall of Fame" comprising 15 or 20 individuals who have contributed most to the Oil, Gas and Petrochemical processing industry. The editors of PETROLEUM REFINER alone will not select those who should be included. Instead, we are calling on a committee of more than 20,000 persons—the readers of PETROLEUM REFINER.

*You* are a member of this committee and we would like for you to submit the name of the one man you think has contributed the most to our great processing industry. Granted, it may be difficult to narrow down your selection to one individual, but we would like for you to do some serious thinking and come up with a choice.

*Then simply write his name* on the special postage-paid postcard on the green page just inside the back cover and drop it in the mail.

We're not setting up special eligibility rules—if you think a man should be nominated, then we do too. When we've heard from those readers who with pride would like to honor the men who have had the big roles in our industry's growth, we are sure to have a list of nominations truly worthy and representative.

From this list, the final choice can be made for the January "Hall of Fame" presentation.

THE EDITORS

# Design Packed Columns Graphically

**Here is a group of diagrams which will make the design of packed columns an easier task. The authors make comparisons with more exacting methods.**

**J. J. Czermann, S. L. Gyokhegyi and J. J. Hay**
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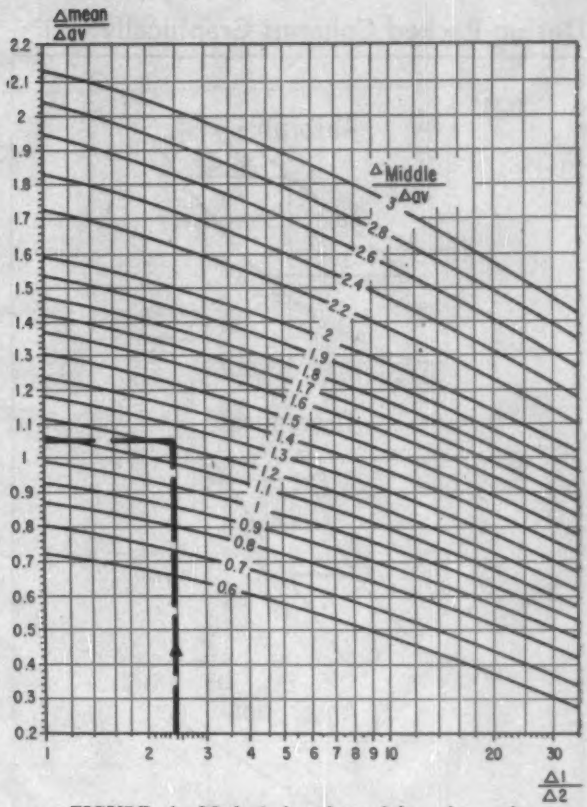



**FIGURE 1—Method for determining the main driving force.**

THE TEDIOUS and complicated calculations for designing packed columns may be made easier with the aid of diagrams. Height, diameter, and pressure drop of the packed column may be obtained in this way. The diagrams presented here were worked out for Raschig-rings, but similar diagrams could be prepared for other types of packing.

No consideration is given for the difference between metal and earthenware rings. It is assumed that the faults committed in this way are less than those of some simplified equations. Later, the exactitude of the diagrams will be shown.

It is not the intention here to give a complete summary of the general questions referring to packed absorption or distillation column designs. Rather, a new graphical method of solution is proposed. Technical literature is referred to on theoretical grounds and general design problems.

To the knowledge of the authors, a complete calculating method of packed absorption and distillation columns by diagrams has not been published. Only the solution of partial problems has appeared.

**Number of Transfer Units.** The height of packed columns is generally calculated with the method of transfer units. For the determination of the number of transfer units the Chilton-Colburn[1] method is the best known. A simple method was also given by Baker.[2] In the case of constant slope of the equilibrium line, the necessary number of transfer units can be easily read on Colburn's diagram.[3] Morris and Jackson[4] show an ingenious method for the driving force in the absorption or distillation process, and through this for the number of transfer units.

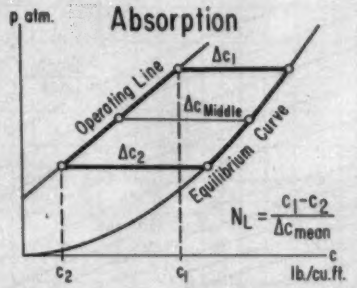
For the reckoning of the driving force Figure 1 is given by Morris and Jackson.

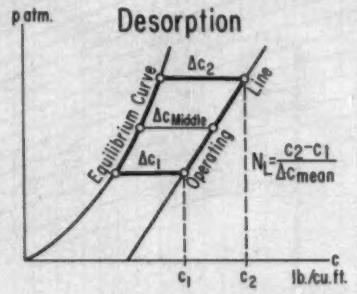
The driving force in absorption processes and by this the number of transfer units can be determined by the difference of partial pressures or liquid concentrations. In distillation processes the differences of vapor concentrations must be considered. The connection between the mean driving force and the number of transfer units for various cases is shown in Figure 2.

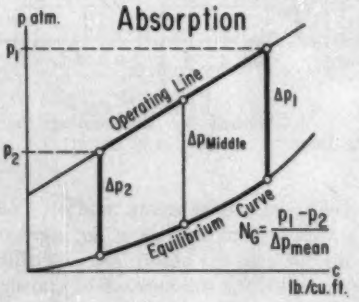
**Diameter of Packed Column.** The cross-section of packed columns is generally determined by the flooding gas or vapor velocity. This theoretical basis was elaborated by Bertetti.[5] Sherwood, Shipley and Holloway[6] gave the first equation, which takes into account the data of packing materials besides the physical gas and liquid properties. The validity of their equation was also confirmed by Elgin and Weiss.[7] The first mentioned authors gave graphical figures of their equations, but their diagrams gave no adequate help to the complicated solution of this equation.

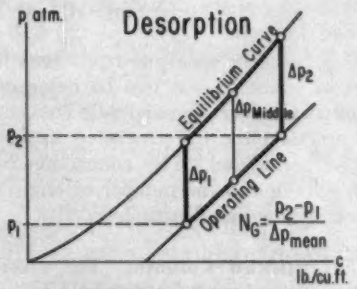
Bain and Hougen[8] worked out their equation, which is based on several other authors' works. The results of Planovskij and Kafarov[9] are substantially similar to those of Bain and Hougen, but the representation of their equation can hardly be depended on as appropriate.

## Design Packed Columns Graphically . . .



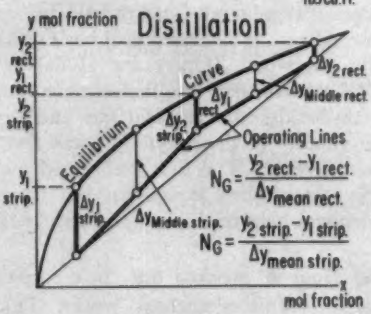




**FIGURE 2—The number of transfer units can be determined by the difference in concentration or vapor pressure.**

The same is to be found in the interpretation of Sherwood and his coworkers.

Kirschbaum[10] gives empirical values as results of his measurements on alcohol-water mixtures. Schumacher[11] plots a more skillful diagram for the simple determination of flooding velocity. As the result of his supposed conditions, the equation and diagram are only suitable for distillation.

Bain and Hougen's[8] equation was used as basis for plotting Figure 3 to determine the flooding velocity on empty tower cross-section. On the right hand of the equation

$$\log \frac{v_0^2 a}{f^3 g} \frac{\rho_a}{\rho_L} \mu^{0.16} = 0.022 - 1.75 \left(\frac{L}{G}\right)^{1/4} \left(\frac{\rho_a}{\rho_L}\right)^{1/8}$$

the term 0.022 was neglected.

The diagram has been extended to cover a wide range of liquid-to-gas ratios. In this way comprises, in addition to distillation, also the absorption range. Simultaneously it makes it possible to take into consideration the variation of packing diameter and the liquid viscosity. To eliminate errors, the invers specific gravity ratio of the Bain and Hougen equation was plotted.

The method of Jacobs[12] was published after our diagrams were prepared. However, we think that our diagrams can be handled more easily.

**Degree of Wetting.** The cross-sectional area given by the flooding gas or vapor velocity and the dimension of packing must be controlled on the basis of the degree of wetting. The first published method on this subject was that of Mayo, Hunter and Nash.[13] Weisman and Bonila[14] plotted their measures graphically, using the results of many other authors, and expressed it also in equations. Pratt[15] gives the minimal effective liquid rate (MELR) to the total wetting of the packed surface. His diagram determines a relation between the degre of wetting and the ratio of actual and minimal effective liquid rate.

Figure 4, to determine the degree of wetting, was plotted on the basis of Pratt's relation. However, we considered the function between the degree of wetting, of packing and the MELR as linear. The diagram makes it possible to read off immediately the degree of wetting, the "periferal velocity" and the volume liquid velocity from the knowledge of liquid rate, packing size, and column diameter.

**Total Packed Height.** The height of a transfer unit, necessary to determine the total height of packing, can be calculated from the gas and liquid film resistances.

The first published data for the evaluation of the height of a transfer unit on liquid film basis; $h_L$, for the system of oxygen-water, was given by Sherwood and Holloway.[16] At a later date Cooper, Christl and Peery[17] gave their results on investigating the system of carbon dioxide-water.

Our method of evaluation for $h_L$ is based on the above mentioned equation of Sherwood and Holloway:[16]

$$h_L = \frac{1}{\alpha} \left(\frac{L}{\mu}\right)^{0.7} \left(\frac{\mu}{\rho_L D_L}\right)^{0.5}$$

The following data are necessary for the determination of the $h_L$: the "periferal liquid velocity" taken from the diagram used for degree of wetting; the temperature of

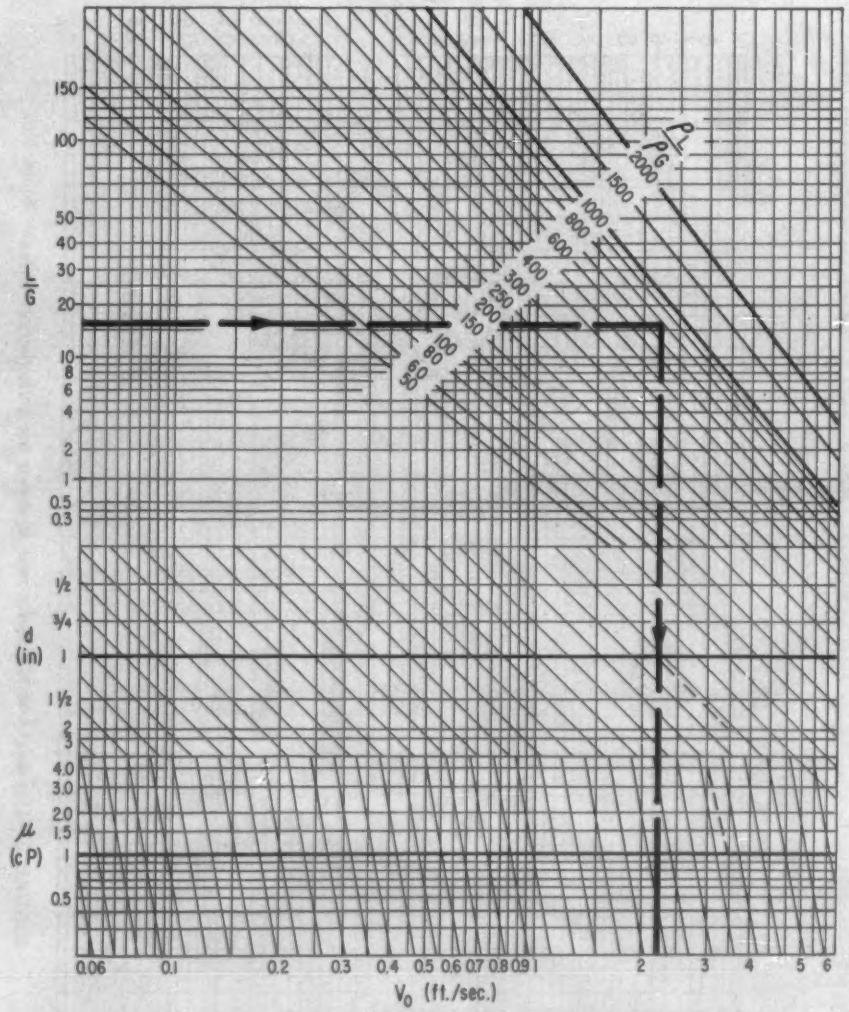



FIGURE 3—The equation by Bain and Hougen was used as a basis for determining the flooding velocity, for an empty tower cross-section.

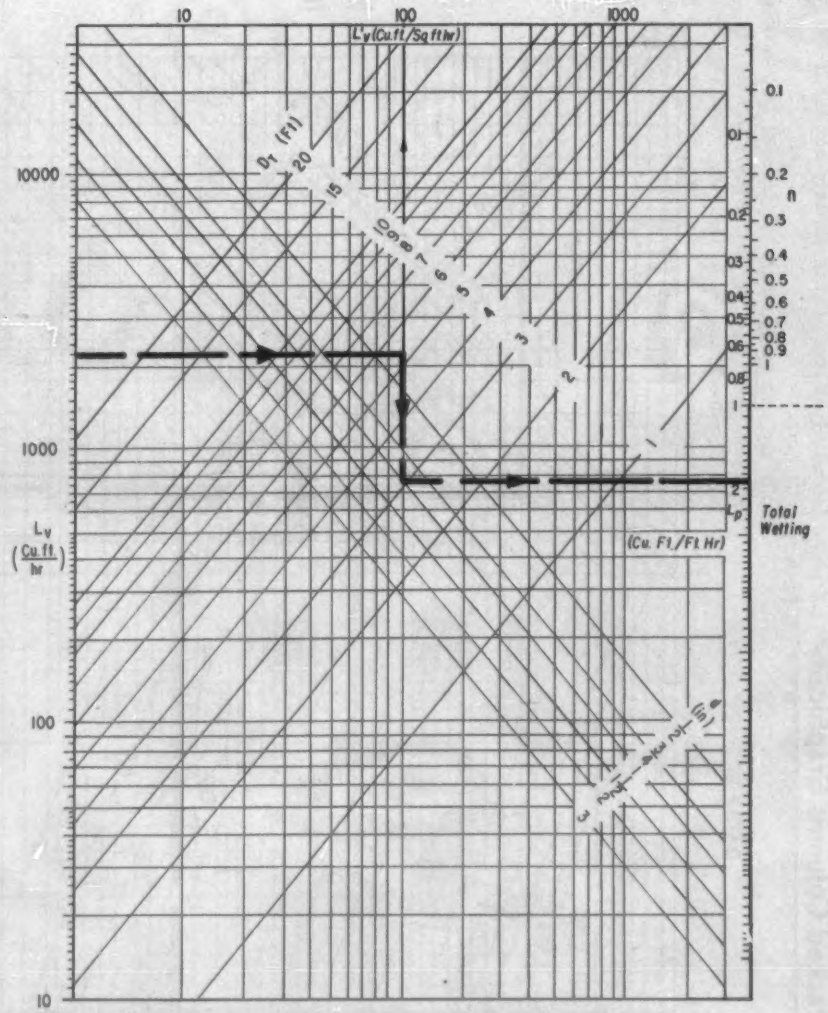



FIGURE 4—The degree of wetting and the volume liquid velocity is related to the liquid rate, packing size, and the column diameter.

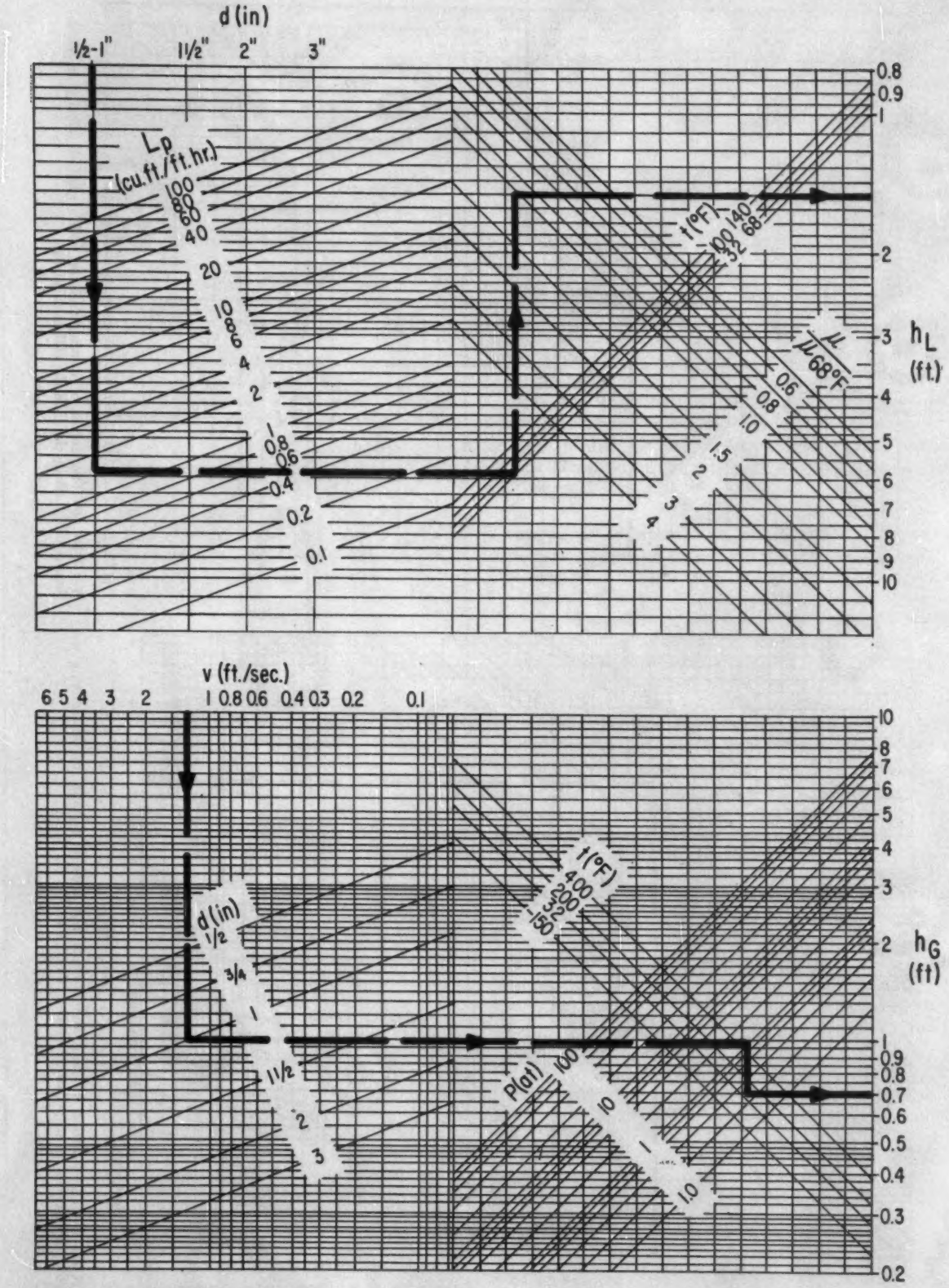



**FIGURE 5—The height of a transfer unit is shown for both the gas and the liquid film.**

liquid; and the liquid viscosity at 68F. and at the actual temperature.

The graphical method of determining the gas film coefficient (the reciprocal of gas film resistance) was first published by Chilton and Colburn.[18] The theoretical and practical investigation of mass transfer operations has resulted in many new equations. Figure 5 for the determination of height of a transfer unit on gas film basis $h_G$ was derived from the equation of Morris[19].

$$h_G = 0.04 \frac{v^*}{P} Re^{-0.28} Sc^{-0.5} \frac{P}{(P-p)_{lm}}$$

We used the equation after rearranging the gas dependent material properties in one term and—as Morris and

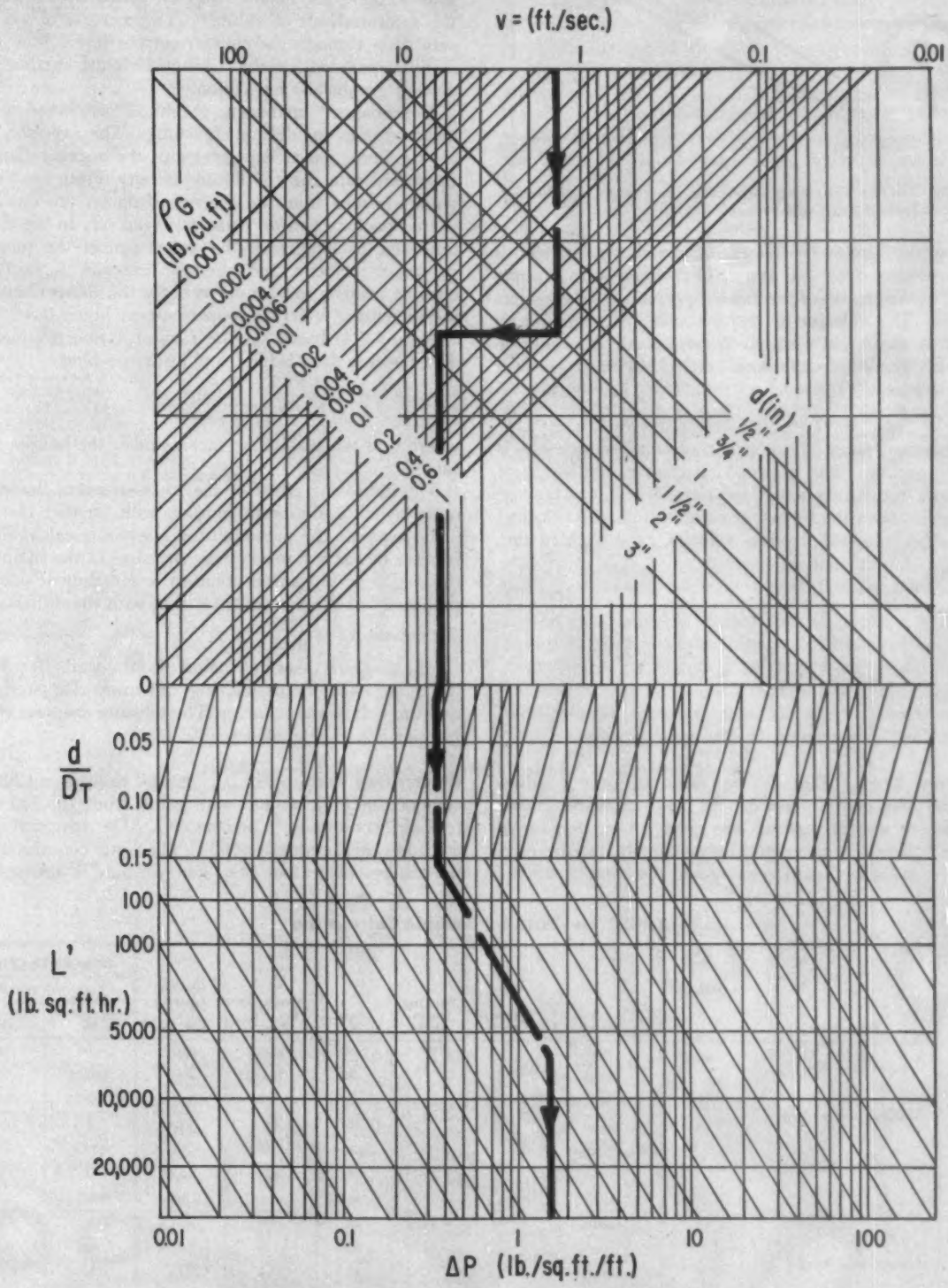



**FIGURE 6—Here is the pressure drop for one foot of dry packing.**

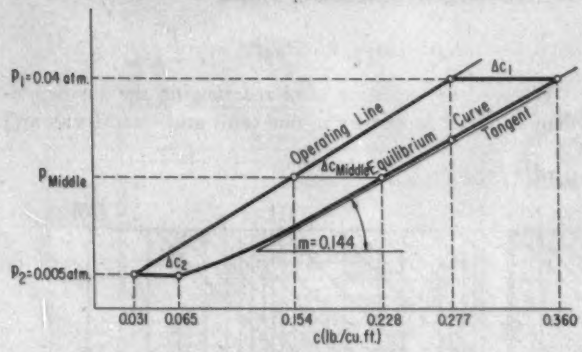



**FIGURE 7—The operating curve for the example problem is calculated from the material balance.**

Jackson have shown it—considered it a constant at standard conditions (68F., 1 atm). Our diagram makes the immediate conversion for other temperatures and pressures possible. The velocity of the gas $v'$ in the equation is related to the liquid surface. Preparing our diagrams we neglected the little difference coming from the surface liquid velocity.

The $\frac{P}{(P-p)_{lm}}$ term of the equation can be taken in consideration, when the concentration of soluble gas is over 10 percent. The neglect of it changes the height of the tower in the direction of security. The $h_G$ can be read off directly from the following data: the "linear velocity" (evaluated from the flooding velocity), the packing size, the temperature, and the pressure.

The total packed height can be evaluated from equation:

$$h = N_G \frac{h_G + r h_L}{n} = N_L \frac{\frac{h_G}{r} + h_L}{n}$$

The value of r can be taken from the slope of equilibrium line, as indicated in the nomenclature.

**Pressure Drop.** The determination of pressure drop with the help of diagrams can be taken from the literature, where several methods are given. The diagram of Tillson[20] gives the pressure drop on 2-inch Raschig-rings from gas or vapor liquid velocity and the specific gravity. A diagram on similar grounds was also published by Sarchet[21] for 1-inch Raschig-rings.

The Chilton-Colburn method[22] which is similar to that of Karman[23] estimates the friction-factor too. The friction-factor can be graphically evaluated from a diagram, where it is plotted as a function of the Reynolds number. The Chilton-Colburn method also takes the wall-effect into account, for hollow rings evaluated by Furnas[24] on the measurements of White[25]. The increase of gas pressure drop through the counter-current liquid flow which is also included in the Chilton-Colburn method, was plotted graphically by Tillson.

Kirschbaum[26] makes a graphical conclusion of his measurements on different packings. The necessary data are the linear gas or vapor velocity, the packing diameter, the liquid rate and the liquid viscosity. From Leva's diagram[27] is seen that the pressure drop on unwetted and wetted packing can be separately read off. In the case of unwetted packing, only the knowledge of the mass gas or vapor velocity and the packing size is necessary, but one needs a surplus diagram for the determination of the increasing effect of countercurrent liquid-flow.

Figure 6 is based on the Chilton-Colburn equations. The pressure drop is for 1 foot of dry packing.

$$\Delta p = \frac{2 f f_1 f_2 v'^2 \rho_G}{g d}$$

where $f_1$ is the wall-effect factor and $f_2$ the hollow shape factor.

The increasing effect of the countercurrent liquid-flow must be taken into consideration with another factor $f_3$.

To evaluate the pressure drop a separate calculation of friction factor is not necessary, because in the main bulk the gas flow in packed columns is a turbulent one. We prepared our diagram only for this, with the utilization of the equation $f = \frac{38}{Re^{0.15}}$.

The diagram takes in account also the wall-effect factor which depends on the packing and tower diameter ratio, and the hollow shape factor. The pressure drop for wetted packing can be read off separately.

**Illustrating Examples.** It is desired to wash out 88 percent of the $SO_2$ content with water from 105,930 cubic feet air, containing 4 percent $SO_2$. The temperature of gas and water is equally at 68 F. The water contains 0.0312 pounds per cubic foot $SO_2$. The pressure is atmospheric.

**TABLE 1—Data for Sample Calculation**

| No. | Operation | Fluid | Pressure Atm. | Packing Diam. Inch | Temp. °F. | Quantity Cu. Ft./ Hour | Specific Gravity Lb./ Cu. Ft. | CONCENTRATIONS Gas: vol. percent Liquid: lb./cu. ft. In | Out |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Absorption of $SO_2$ | Air | 1 | 1 | 68 | 106,000 | 0.076 | 4.00 | 0.50 |
| | | Water | | | 68 | 2242 | 62.4 | 0.0312 | 0.277 |
| 2 | Absorption of Acetone | Gas Mixture | 1 | 1 | 95 | 35,300 | 0.073 | 2.66 | 0.13 |
| | | Water | | | 77 | 90 | 62.4 | 0 | 1.37 |
| 3 | Absorption of $CO_2$ | Gas Mixture | 15 | 1 | 68 | 20,800 | 1.1 | 43.70 | 0.20 |
| | | Water | | | 73 | 2470 | 62.4 | 0 | 0.454 |
| 4 | Absorption of Water/Drying | HCl | 1 | 1 | 68 | 1250 | 0.092 | 0.80 | 2.73 |
| | | $H_2SO_4$ | | | 68 | 57 | 117 | 0 | 0.259 |
| 5 | Absorption of Alcohol | Air | 1 | 2 | 86 | 3740 | 0.073 | 0.98 | 0.17 |
| | | Cresol | | | 86 | 35.3 | 62.4 | 0.624 | 1.835 |

The dimensions of the absorption column should be determined.

The equilibrium curve with the necessary data is given by Figure 7. The operating line is calculated from the material balance, and from these, the needed quantity of water is 2242 cubic feet per hour.

The steps to calculate the given example are indicated in the diagrams by broken lines. Each step is discussed as follows:

$\Delta C_M = 0.073$
$\Delta C_1 = 0.084$
$\Delta C_2 = 0.034$
$\Delta C_{av} = \frac{1}{2} (\Delta C_1 + \Delta C_2)$
$= 0.059$
$\Delta C_1/\Delta C_2 = 2.45$
$\Delta C_M/\Delta C_{av} = 1.23$
$\Delta C_m/\Delta C_{av} = 1.06$ (Figure 1)
$\Delta C_m = 0.0626$ lb/cu ft
$N_L = 3.9$ (Figure 2)
$L/G = 15.7$
$\rho_L/\rho_G = 740$
$d = 1.0$ in
$\mu = 1$ cp
$v_o = 2.23$ ft/sec (Figure 3)
Note: if $d = 2$ in
and $\mu = 4$ cp
then $v_o = 3$ ft/sec
Select $D_T = 5.25$ ft
Corrected Linear Velocity (v)
$= 1.36$ ft/sec
Percent of Flooding $= 60$
$L_v = 2242$ cu ft/hr
$L'_v = 100$ cu ft/sq ft hr
$L_p = 1.85$ cu ft/ft hr (Figure 4)
$n > 1$ Therefore, the type of packing is correct for proper degree of wetting.
$t = 68$ F
$\mu/\mu_{68F} = 1$
$h_L = 1.5$ ft (Figure 5)
$P = 1$ atm
$h_G = 0.7$ ft
Slope (m) $= 0.144$ (Figure 7)
$r = 1.14$

$$h = N_L \left[ \frac{(h_G/r) + h_L}{n} \right]$$

$= 8.1$ ft
$\rho_G = 0.084$ lb/cu ft
$d/D_T = 0.015$ (Figure 6)
Dry Pressure Drop $= 0.35$ psf/ft
$L' = 6400$ lb/sq ft hr
Wet Pressure Drop $= 1.6$ psf/ft (Figure 6)
Total Pressure Drop on Wetted Packing
$= 12.9$ psf

**Exactitude of Method.** We compared our graphical method with several samples of which we give a selection in Table 1. In these samples we compared the results of our diagrams with those of control calculations in Table 2. When not mentioned in the calculation we employed the method described in the foregoing example.

The illustrated example, which is shown on the diagrams, was also calculated numerically. The number of transfer units was determined by graphical integration, the flooding velocity from the Bain and Hougen equation,[8] the degree of wetting and the $h_G$ with the method used by Pratt,[15] the $H_L$ using the Sherwood-Holloway relation,[16] and the pressure drop with the results of Chilton-Colburn.[22]

In the second example the gas and liquid film is simultaneously controlling.

In the third example (absorption of carbon dioxide in water) the pressure is not atmospheric; the liquid film alone is controlling. The chosen example is interesting from that point of view that the gas liquid ratio is nearly on the limit of validity of the Bain and Hougen equation. In the calculation we determined the number of transfer units through analytical methods, because the equilibrium curve was linear. The other results were taken as mentioned before. As a result of the low gas velocity and high liquid rate the pressure drop was obtained by extrapolation.

The fourth example (drying of HCl with sulfuric acid) was chosen as one, where only the gas film resistance is controlling.

The fifth example (absorption of alcohol in cresol) shows a relatively high liquid viscosity and a packing diameter which differs from the other examples. The controlling film is the gas film; the role of the liquid film is neglected.

**TABLE 2—Comparison of Graphical and Numerical Methods**

| Operation | Solution Method | Number of Transfer Units | Flooding Velocity | Periferal Rate | Degree of Wetting | Height of Transfer Units | | Slope of Equilibrium Curve | Total Packed Height | Pressure Drop |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Gas-film Basis | Liquid-film Basis | | | |
| | | N | $v_o$ | $L_P$ | n | $h_G$ | $h_L$ | m | h | $\Delta P$ |
| | | | Ft./Sec. | Cu. Ft. / Hr. Ft. | | Ft. | Ft. | Atm. Cu. Ft./Lb. | Ft. | Lb./Sq. Ft./Ft. |
| 1 Absorption of $SO_2$.... | Numeric | 3.8 | 2.23 | 1.80 | 1 | 0.61 | 1.58 | 0.158 | 8.0 | 1.79 |
| | Graphic | 3.9 | 2.23 | 1.85 | 1 | 0.7 | 1.52 | 0.142 | 8.1 | 1.63 |
| 2 Absorption of Acetone | Numeric | 7.5 | 5.16 | 0.525 | 0.73 | 0.98 | 1.0 | 0.017 | 18.6 | 4.54 |
| | Graphic | 7.5 | 4.77 | 0.520 | 0.70 | 0.89 | 0.92 | 0.018 | 18.6 | 4.23 |
| 3 Absorption of $CO_2$.... | Numeric | 15.6 | 0.09 | 6.95 | 1 | — | 2.36 | — | 36.9 | 0.23 |
| | Graphic | 15.6 | 0.08 | 7.20 | 1 | — | 2.44 | — | 37.8 | 0.20 |
| 4 Drying with $H_2SO_4$... | Numeric | 2 | 3.75 | 0.475 | 0.68 | 0.65 | — | — | 1.94 | 1.89 |
| | Graphic | 2 | 3.80 | 0.463 | 0.64 | 0.72 | — | — | 2.25 | 1.76 |
| 5 Absorption of Alcohol | Numeric | 3.62 | 9.0 | 0.516 | 0.73 | 2.67 | — | — | 13.3 | 2.02 |
| | Graphic | 3.62 | 8.9 | 0.463 | 0.60 | 2.24 | — | — | 13.5 | 1.56 |
| 6 Acetone-Water Dist... | Numeric | 2.34 | 3.42 | 0.36 | 0.50 | 0.78 | — | — | 3.66 | 1.22 |
| | Graphic | 2.1 | 3.55 | 0.36 | 0.49 | 0.92 | — | — | 3.94 | 1.23 |
| 7 Acetone-Water Dist... | Numeric | 13.27 | 3.52 | 0.28 | 0.40 | 0.61 | — | — | 20.3 | 2.47 |
| | Graphic | 11.27 | 3.28 | 0.29 | 0.38 | 0.79 | — | — | 23.4 | 2.14 |

## Design Packed Columns Graphically . . .

In the last two examples we show the applicability of our diagrams on packed distillation column problems. The sixth and seventh example gives the result of calculations on an acetone water-distillation column, separate for the stripping and rectifying section.

In this case the vapor-liquid equilibrium curve greatly differs from the ideal.

The supposition was that the column operates adiabatically and is supplied with a total condensator. The difference between the heats of vaporization was neglected.

The data for examples six and seven are given in Table 3.

**TABLE 3**
**Data for Distillation Calculation**

| | FEED | | DISTILLATE | | BOTTOM | |
|---|---|---|---|---|---|---|
| | Lb./ Hour | Weight Percent | Lb./ Hour | Weight Percent | Lb./ Hour | Weight Percent |
| Acetone..... | 1000 | 50 | 1000 | 99 | — | 0.02 |
| Water..... | 1000 | 50 | 10 | 1 | 990 | 99.98 |
| | 2000 | 100 | 1010 | 100 | 990 | 100.00 |

Feed conditions: 122°F., reflux ratio 1:1.5, 1-in. Raschig-rings.

As indicated in Table 2, the results obtained from our diagrams or calculated numerically agree with each other fairly closely. The results obtained from the different relations used in determining the main dimensions of packed columns, greatly diverge from each other. The inaccuracy committed by using the new graphical method, is still less than the above mentioned.

The use of the new graphical method is preferable especially in such cases, where the determination of some dimensions must be approached by trial and error. For example the flooding velocity has to be determined by a self chosen packing diameter, but this must be controlled from the standpoint of wetting. If the selected diameter is not appropriate, the process should be repeated. The same can occur for example by the design of vacuum towers, where the dimensions must be controlled after the calculation of pressure drop.

### About the Authors

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### NOMENCLATURE

| | |
|---|---|
| $D_T$ | Tower diameter, ft. |
| G | Gas rate, lb./hr. |
| L | Liquid rate, lb./hr. |
| Lp | Periferal liquid rate, lb./hr. ft. |
| $N_G$ | Number of transfer units on gas film basis |
| $N_L$ | Number of transfer units on liquid basis |
| P | Total gas pressure, atm. |
| $\Delta P$ | Pressure drop, lb./sq. ft. |
| c | Concentration of solution, lb./cu. ft. |
| d | Diameter of Raschig-rings, in. |
| g | Gravitational acceleration, ft./sec.$^2$ |
| h | Height of packing, ft. |
| $h_G$ | Height of a transfer unit on gas film basis, ft. |
| $h_L$ | Height of a transfer unit on liquid basis, ft. |
| m | Slope of equilibrium curve |
| n | Degree of wetting |
| p | Partial pressure of soluble gas, atm. |
| r | Conversion factor $r = \frac{G_T \rho_s}{L_T P_m}$ |
| t | Temperature, °F. |
| $v_0$ | Flooding gas velocity, ft./sec. |
| v | Linear gas velocity, ft./sec. |
| $\Delta M$ or $\Delta$ middle | Driving force at middle perition on gas or liquid basis |
| $\Delta m$ or $\Delta$ mean | Mean driving force on gas or liquid basis |
| $\mu$ | Viscosity of solution, cp. |
| $\rho_G$ | Specific gravity of gas, lb./cu. ft. |
| $\rho_L$ | Specific gravity of liquid, lb./cu. ft. |
| $\rho_s$ | Specific gravity of soluble gas, lb./cu. ft. |

**Indices:**

| | |
|---|---|
| 1 | refers to column head |
| 2 | refers to column base |
| rect. | refers to rectifying section |
| stripp. | refers to stripping section |
| v | refers to volume rate |
| ' | refers to cross-sectional rate |

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# Applied Hydrocarbon Thermodynamics

## Part 4 Compressibility Factors and Equations of State

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SPECIFIC VOLUMES or densities of vapors and liquids are frequently estimated from generalized correlations of compressibility factor ($z = PV/RT$) plotted against reduced pressure and temperature. Empirical equations of state are also used for this purpose.

**Improved Compressibility Factor Correlations.** Compressibility factors have been correlated for hydrocarbons by plotting z against reduced pressure and temperature. This simple generalized correlation has been useful for estimating vapor densities; but it is of limited accuracy, as the z values for all components at the same $T_r$ and $P_r$ do not agree.

Recently[4,6,9,10] the theorem of corresponding states has been extended by introducing another parameter for characterizing the molecules. Lydersen, et al.[4], used the value of $z_c$, the critical point compressibility factor, which is 0.290 for methane and 0.247 for n-decane. For hydrogen and water the values of $z_c$ are 0.304 and 0.230, respectively. Meissner and Seferian[6] had proposed a similar three-parameter generalized compressibility factor correlation.

In the Meissner and Seferian correlation, compressibility factors for compounds for which $z_c = 0.27$ were given as a function of $P_r$ and $T_r$. Separate correction factor plots were given for other $z_c$ values. Using this correlation to find a value of z involves reading two charts and multiplying the two readings.

In the Lydersen, et al., three-parameter ($P_r$, $T_r$, $z_c$) compressibility factor correlations, tabulations are given for four values of $z_c$ (0.23, 0.25, 0.27, and 0.29). For each of these $z_c$ classifications, generalized thermodynamic properties (i.e., entropy, enthalpy, fugacity, etc.) were derived and tabulated by these authors also.

Riedel[10] extended the theorem of corresponding states, using the slope of the vapor pressure curve at the critical point as a characterizing parameter.

Pitzer, et al.[9], introduced a characterizing third parameter, $\omega$, called the acentric factor. $\omega$ is defined by the reduced vapor pressure at $T_r = 0.7$ as follows:

$$\omega = \left[\log (P_r^\circ)_{T_r = 0.7} + 1.00\right] \qquad (4.1)$$

For a simple fluid $\omega = 0.000$. The value of $\omega$ for a substance is a measure of deviation of simple fluid P-V-T behavior. Values of $\omega$ and critical constants are given in Tables 4.1 and 4.2.

The constants tabulated by Pitzer are given in Table 4.1. Similar data for many more substances are given in Table 4.2.

In terms of this acentric factor, the compressibility factor is found by the following:

$$z = z^\circ + \omega z' \qquad (4.2)$$

where: $z^\circ$ = compressibility factor for simple fluid
$z'$ = compressibility factor correction for deviation from simple fluid

Both $z^\circ$ and $z'$ are functions of $T_r$ and $P_r$.

Using this method to find z for any gas involves reading two charts to get values of $z^\circ$ and $z'$ from the reduced conditions and applying Equation 4.2. The acentric factor method is more convenient to use than the critical compressibility factor method. For this reason working plots for the former method have been prepared from the available tabular data.[9]

**Saturated Vapor and Liquid.** Values of $z^\circ$ and $z'$ for saturated vapor and liquid may be found from tables or plots employing a single reduced parameter, either $T_r$ or $P_r$. Separate plots have been prepared from the original tabulations. The subscripts P and T are used to identify the correlation parameter ($P_r$ or $T_r$) of $z^\circ$ and $z'$. Readings of $z^\circ$ and $z'$ from temperature and pressure charts should not be mixed.

Figure 4.1 is a plot of $z_P^\circ$ and $z_P'$ versus reduced pressure for saturated liquid and vapor. Readings are combined as follows to give the saturated liquid or vapor compressibility factor:

$$z = z_P^\circ + z_P' \qquad (4.3)$$

Figure 4.2 is a plot of $z_T^\circ$ $z_T'$ versus reduced temperature for saturated liquid and vapor. Readings are combined as follows to give the saturated liquid or vapor compressibility factor.

$$z = z_T^\circ + \omega z_T' \qquad (4.4)$$

If the value of z is found for the saturated liquid or vapor of any substance by applying Equation 4.2 with readings from Figure 4.1 and also by applying Equation 4.3 with reading from Figure 4.2, it will be found that these values agree. However, it should be noted that:

$$z_P^\circ = z_T^\circ \text{ when } \omega = 0$$
$$z_P^\circ \neq z_T^\circ \text{ when } \omega \neq 0$$

This difference must exist because of the differences in reduced vapor pressure when $\omega \neq 0$.

**Nonsaturated States.** Two plots, in $T_r$ and $P_r$ parameters, gives the values of $z^\circ$ and $z'$ for all nonsaturated

**TABLE 4.1**
**Acentric Factors and Critical Constants for Substances Covered By Pitzer et al[9]**

| SUBSTANCE | Normal Boiling Point $T_B$ °K | Normal Boiling Point $T_B$ °R | Critical Constants Tc °K | Tc °R | Pc Atm | Pc psia | Acentric Factors, ω Method I (Note 1) | Method II (Note 2) | Difference $\omega_{II}-\omega_I$ |
|---|---|---|---|---|---|---|---|---|---|
| Argon | 87.5 | 157.6 | 150.72 | 271.3 | 48.0 | 705.0 | —0.002 | —0.003 | —0.001 |
| Krypton | 120.3 | 216.3 | 209.39 | 478.0 | 54.182 | 796.2 | —0.002 | +0.003 | +0.005 |
| Xenon | 166.1 | 298.9 | 289.75 | 521.6 | 57.636 | 847.0 | +0.002 | 0.014 | +0.012 |
| Methane | 111.7 | 201.0 | 190.66 | 343.2 | 45.795 | 673.0 | 0.013 | 0.007 | —0.006 |
| Nitrogen | 77.4 | 139.3 | 126.26 | 227.3 | 33.54 | 492.9 | 0.04 | 0.036 | —0.004 |
| Hydrogen Sulfide | 212.8 | 383.0 | 373.55 | 672.4 | 88.868 | 1306.0 | 0.10 | 0.106 | +0.006 |
| Ethane | 184.6 | 332.2 | 305.75 | 540.4 | 48.864 | 718.1 | 0.105 | 0.103 | —0.002 |
| Propane | 231.2 | 416.0 | 369.99 | 665.9 | 42.011 | 617.4 | 0.152 | 0.159 | +0.007 |
| Neopentane | 282.7 | 508.8 | 433.76 | 780.8 | 31.57 | 464.0 | 0.195 | 0.203 | +0.004 |
| n-Butane | 272.7 | 490.8 | 425.17 | 765.3 | 37.47 | 550.7 | 0.201 | 0.206 | +0.005 |
| Benzene | 353.2 | 635.9 | 562.66 | 1012.8 | 48.664 | 715.2 | 0.215 | 0.219 | +0.004 |
| Carbon Dioxide[3] | .... | .... | 304.2 | 547.7 | 72.8 | 1070.0 | 0.225 | — | — |
| n-Pentane | 309.3 | 556.6 | 470.60 | 847.1 | 33.628 | 494.2 | 0.252 | 0.255 | +0.003 |
| Ammonia | 239.8 | 431.7 | 406.0 | 729.7 | 112.31 | 1650.5 | 0.250 | 0.268 | +0.018 |
| Water | 373.2 | 671.7 | 647.66 | 1165.4 | 219.515 | 3226.0 | 0.348 | 0.365 | +0.017 |
| n-Heptane | 371.6 | 668.9 | 539.94 | 971.9 | 26.882 | 395.1 | 0.352 | 0.352 | 0.0 |

**Note 1:** Method I Equation definition by Pitzer, et al [9].
$\omega = -[\log Pr + 1]$ (at $Tr = 0.7$);

**Note 2:** Method II Approximate Equation

$$\omega = \frac{3}{7}\left\{\frac{\log Pc\ Atm}{\frac{Tc}{T_B} - 1}\right\} - 1$$

**Note 3:** Method II is not applicable to $CO_2$ because this compound has no normal boiling point.

**Note 4:** APT 44 Values of Criticals and ω Factors for Some Components in Table 4.1

| Compound | N.B.P. °K | N.B.P. °R | Critical Constants Tc °K | Tc °R | Pc Atm | Pc Psia | Acentric Factors, ω Method I | Method II | Difference ωII-ωI |
|---|---|---|---|---|---|---|---|---|---|
| Methane | 111.7 | 201.0 | 191.06 | 343.91 | 45.80 | 673.1 | 0.017 | 0.012 | —0.005 |
| Ethane | 184.6 | 332.2 | 305.56 | 550.01 | 48.30 | 709.8 | 0.095 | 0.099 | +0.004 |
| n-Pentane | 309.3 | 556.6 | 469.78 | 845.6 | 33.31 | 439.5 | 0.250 | 0.257 | +0.004 |
| n-Heptane | 371.6 | 668.9 | 540.17 | 972.31 | 27.00 | 396.8 | 0.356 | 0.352 | —0.004 |
| Benzene | 353.2 | 635.9 | 562.61 | 1012.7 | 48.6 | 714.0 | 0.210 | 0.219 | +0.009 |

states. This includes: superheated vapor, subcooled liquid, and the dense phase region. Figure 4.3 is a plot of $z^\circ$ against $P_r$ for lines of constant $T_r$. Figure 4.4 is a plot of $z'$ against $T_r$ for lines of constant $P_r$.

These two plots were made from the published tabulations. Abscissa and parameter were reversed for convenience in plotting. As can be seen, the correction for deviation from the simple fluid compressibility factors is appreciable.

**Acentric Factor Effect on z.** As an illustration, the values of z will be found at $P_r = 2.0$ and $T_r = 1.0$ for ammonia and methane for which $\omega = 0.25$ and 0.013, respectively. For comparison, the values of z will also be found for these same gases at $P_r = 2.0$ and $T_r = 2.0$. From the above it can be seen that there is an appreciable difference between the compressibility factors for these two gases at both points; whereas, the $z^\circ$'s are the same.

From this improved generalized correlation of compressibility factors, various thermodynamic properties

| Reduced Pressure, $P_r$ / Reduced Temp., $T_r$ | 2.0 / 1.0 | | 2.0 / 2.0 | |
|---|---|---|---|---|
| $z^\circ$, Figure 4.3 | 0.330 | | 0.958 | |
| $z'$, Figure 4.4 | —0.123 | | +0.155 | |
| | $CH_4$ | $NH_3$ | $CH_4$ | $NH_3$ |
| ω | 0.013 | 0.250 | 0.013 | 0.250 |
| (ω) (z') | —0.0016 | —0.0308 | +0.0020 | +0.0388 |
| $z = z^\circ + \omega z'$ | 0.328 | 0.299 | 0.960 | 0.997 |

can be found by graphical or analytical calculations starting with the $z^\circ$ ($P_r$, $T_r$) and the $z'$ ($P_r$, $T_r$) correlations. This would give the isothermal effect of pressure on the enthalpy, etc., in two parts, to be combined by means of the acentric factor. Use of these charts with the proper value of ω is a convenient and accurate way

**TABLE 4.2—Acentric Factors and Critical Constants for Additional Compounds**

| SUBSTANCE | Normal Boiling Points $T_B$ °K | Normal Boiling Points $T_B$ °R | Critical Constants Tc °K | Tc °R | Pc Atm | Pc psia | Acentric Factors, ω Method I (Note 1) | Method II (Note 2) | Difference $\omega_{II}-\omega_I$ |
|---|---|---|---|---|---|---|---|---|---|
| Oxygen | 90.2 | 162.3 | 154.9 | 278.6 | 50.1 | 736.9 | +0.0213 | +0.0156 | —0.0057 |
| Carbon Monoxide | 81.7 | 147.1 | 133.0 | 240.0 | 34.43 | 506.0 | 0.041 | 0.0490 | +0.004 |
| Acetylene | 189.3 | 340.7 | 309.5 | 557.4 | 61.58 | 905.0 | 0.1858 | 0.2077 | +0.0219 |
| Propene | 225.5 | 405.8 | 365.0 | 656.9 | 45.39 | 667.0 | 0.1427 | 0.1476 | +0.0049 |
| Isobutane | 261.6 | 470.6 | 408.2 | 734.7 | 36.0 | 529.0 | 0.1918 | 0.1902 | —0.0016 |
| Isobutene | 266.3 | 479.3 | 417.9 | 752.2 | 39.39 | 579.8 | 0.2007 | 0.2010 | +0.0003 |
| Butene-1 | 266.9 | 480.4 | 419.6 | 755.2 | 39.67 | 583.0 | 0.2027 | 0.1974 | —0.0043 |
| Butene-2 cis | 277.0 | 498.4 | 428.2 | 770.7 | 40.83 | 600.0 | 0.2725 | 0.2650 | —0.0075 |
| Butene-2 trans | 274.1 | 493.3 | 428.2 | 770.7 | 40.83 | 600.0 | 0.2336 | 0.2281 | —0.0055 |
| Toluene | 383.8 | 690.8 | 593.8 | 1069.2 | 40.15 | 590.0 | 0.2518 | 0.2560 | +0.0042 |
| Isopentane | 301.0 | 541.8 | 460.9 | 829.7 | 32.86 | 483.0 | 0.206 | 0.2240 | +0.0180 |
| Hexane | 341.8 | 615.4 | 507.8 | 914.2 | 29.93 | 440.0 | 0.2899 | 0.3016 | +0.0117 |
| Cyclopentane | 322.4 | 580.4 | 511.7 | 921.2 | 44.55 | 655.0 | 0.1925 | 0.2060 | +0.0135 |
| Methylcyclopentane | 545.0 | 621.0 | 532.7 | 959.0 | 37.34 | 549.0 | 0.2343 | 0.2386 | +0.0043 |
| Cyclohexane | 353.8 | 637.0 | 554.2 | 997.7 | 38.16 | 561.0 | 0.1858 | 0.1974 | +0.0116 |
| Methanol | 337.7 | 607.8 | 513.2 | 923.7 | 78.46 | 1153.0 | 0.5560 | 0.5624 | +0.0064 |
| Ethanol | 351.5 | 632.6 | 516.3 | 929.3 | 63.15 | 928.0 | 0.6351 | 0.6459 | +0.0108 |

**Note 1:** Method I Equation definition by Pitzer, et al [9].
$\omega = -[\log Pr + 1]$ (at $Tr = 0.7$)

**Note 2:** Method II Approximate Equation

$$\omega = \frac{3}{7}\left\{\frac{\log Pc\ Atm}{\frac{Tc}{T_B} - 1}\right\} - 1$$

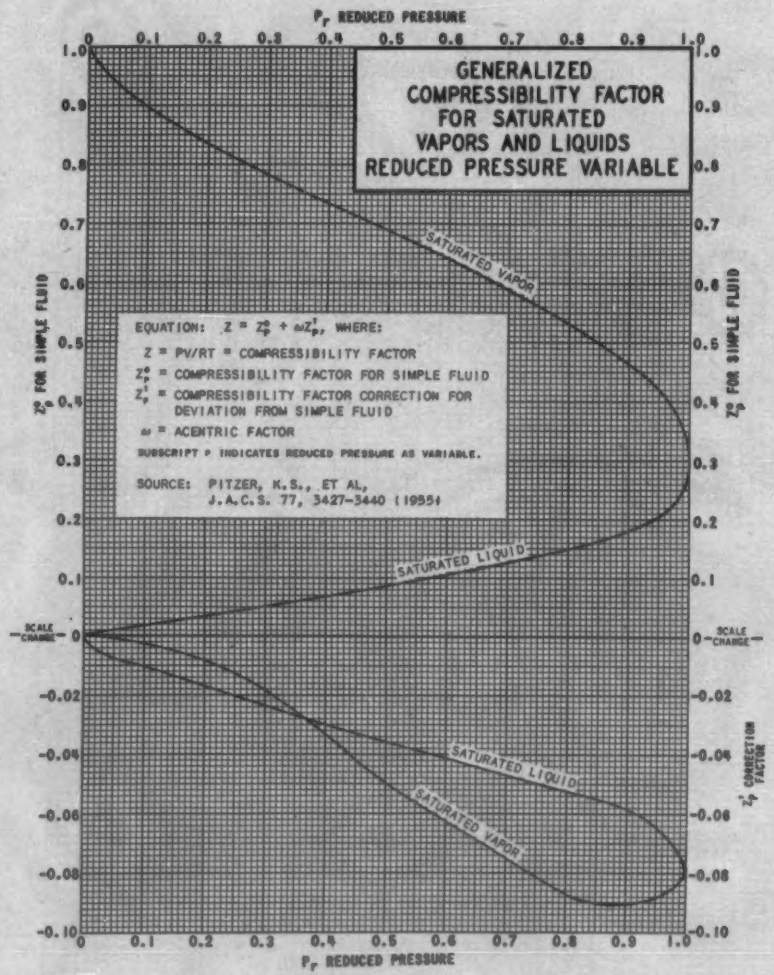
GENERALIZED
COMPRESSIBILITY FACTOR
FOR SATURATED
VAPORS AND LIQUIDS
REDUCED PRESSURE VARIABLE
EQUATION: Z = Z_P^0 + ωZ_P^1, WHERE:
Z = PV/RT = COMPRESSIBILITY FACTOR
Z_P^0 = COMPRESSIBILITY FACTOR FOR SIMPLE FLUID
Z_P^1 = COMPRESSIBILITY FACTOR CORRECTION FOR DEVIATION FROM SIMPLE FLUID
ω = ACENTRIC FACTOR
SUBSCRIPT P INDICATES REDUCED PRESSURE AS VARIABLE.
SOURCE: PITZER, K.S., ET AL, J.A.C.S. 77, 3427-3440 (1955)
P_r REDUCED PRESSURE
Z_P^0 FOR SIMPLE FLUID
Z_P^1 CORRECTION FACTOR
SATURATED VAPOR
SATURATED LIQUID
SATURATED LIQUID
SATURATED VAPOR
SCALE CHANGE

FIGURE 4.1—Generalized compressibility factor for saturated vapors and liquids as a function of reduced pressure.

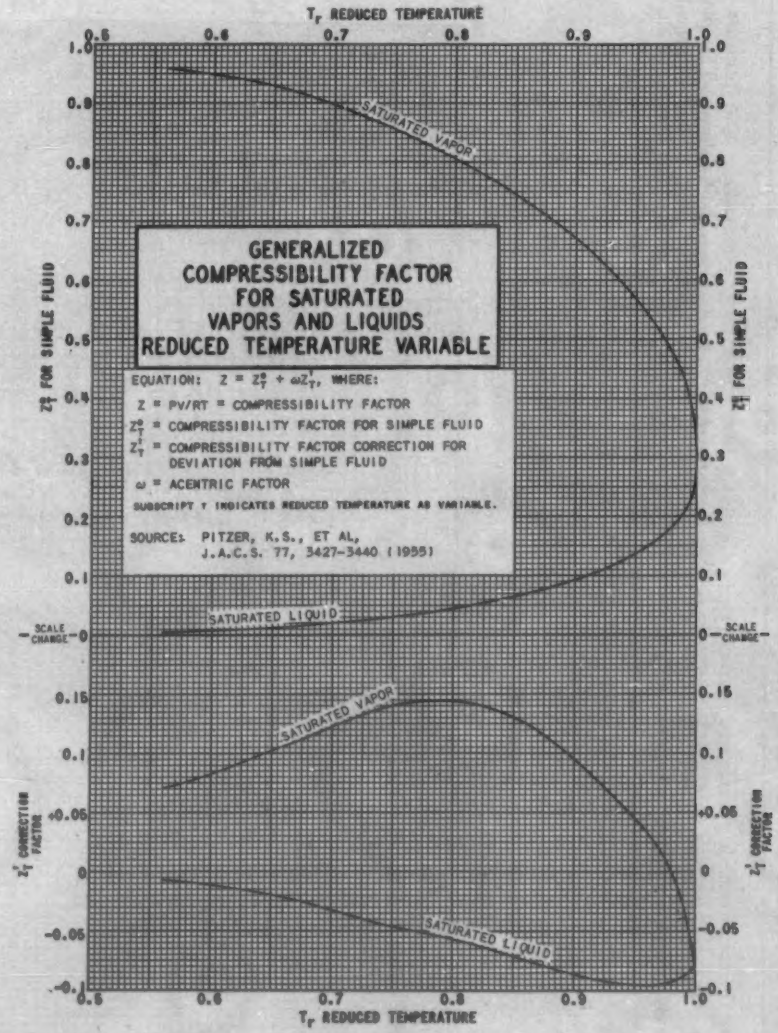
GENERALIZED
COMPRESSIBILITY FACTOR
FOR SATURATED
VAPORS AND LIQUIDS
REDUCED TEMPERATURE VARIABLE
EQUATION: Z = Z_T^0 + ωZ_T^1, WHERE:
Z = PV/RT = COMPRESSIBILITY FACTOR
Z_T^0 = COMPRESSIBILITY FACTOR FOR SIMPLE FLUID
Z_T^1 = COMPRESSIBILITY FACTOR CORRECTION FOR DEVIATION FROM SIMPLE FLUID
ω = ACENTRIC FACTOR
SUBSCRIPT T INDICATES REDUCED TEMPERATURE AS VARIABLE.
SOURCE: PITZER, K.S., ET AL, J.A.C.S. 77, 3427-3440 (1955)
T_r REDUCED TEMPERATURE
Z_T^0 FOR SIMPLE FLUID
Z_T^1 CORRECTION FACTOR
SATURATED VAPOR
SATURATED LIQUID
SATURATED VAPOR
SATURATED LIQUID
SCALE CHANGE

FIGURE 4.2—Generalized compressibility factor for saturated vapors and liquids as a function of the reduced temperature.

of estimating the compressibility factor and deriving thermodynamic properties for any substance.

**Estimation of Acentric Factor.** Equation 4.1 defines $\omega$, and a few typical values are given. Values of $\omega$ can be readily found from critical point and vapor pressure data. A more convenient way of finding $\omega$ for any substance uses the critical temperature and pressure and the atmospheric boiling point, as follows. The plot of the logarithm of reduced pressure versus reciprocal reduced temperature is a straight line:

$$\log P_r^\circ = m\left(1 - \frac{1}{T_r}\right) \qquad (4.5)$$

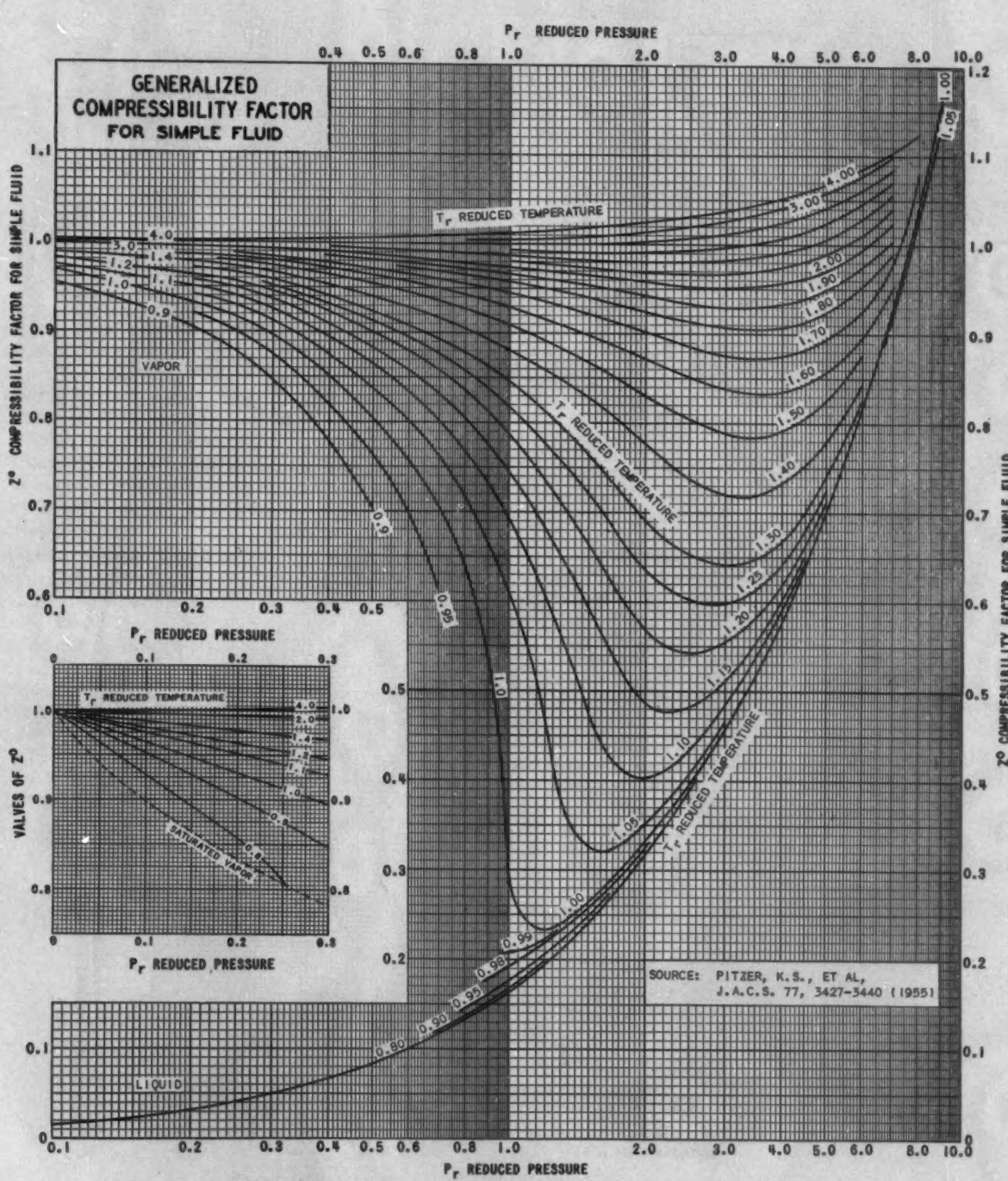


**FIGURE 4.3—Generalized compressibility factor for simple fluid.**

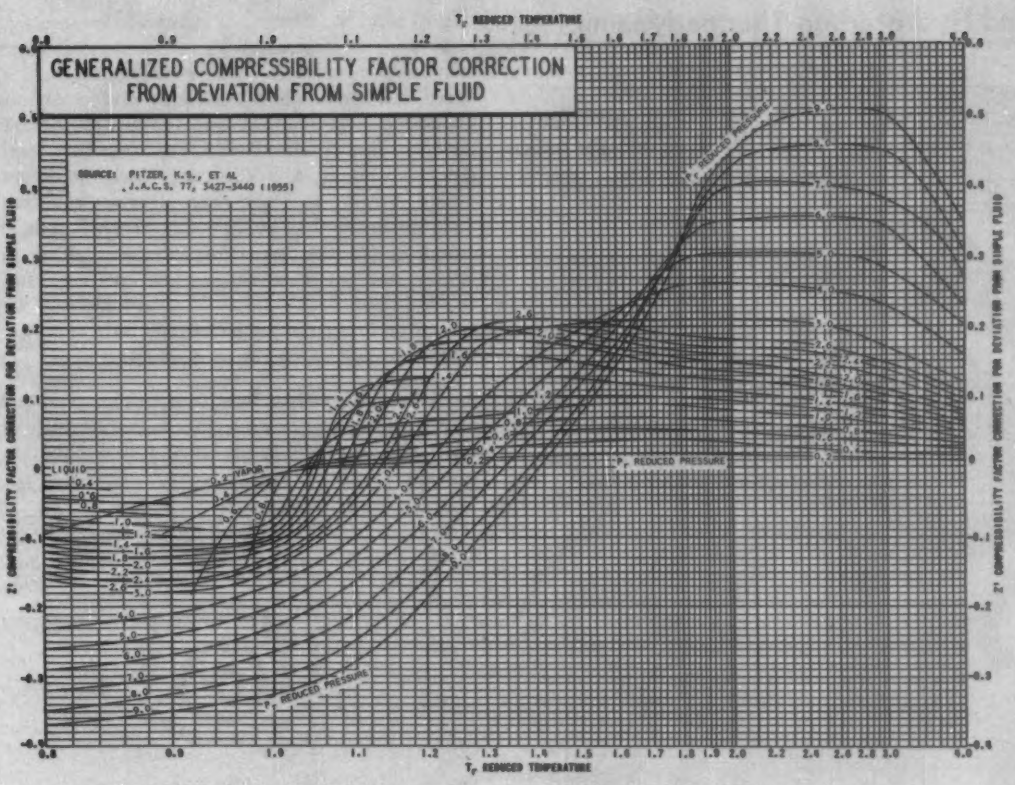


**FIGURE 4.4—Generalized compressibility factor correction for deviation from simple fluid.**

where:

$$m = \frac{\log\left(\frac{P_c}{14.7}\right)}{\frac{T_c}{T_B} - 1} \qquad (4.6)$$

Combining Equations 4.1, 4.5, and 4.6 at $T_r = 0.7$ gives:

$$\omega = \frac{3}{7}\left(\frac{\log\left(\frac{P_c}{14.7}\right)}{\frac{T_c}{T_B} - 1.00}\right) - 1.0 \qquad (4.7)$$

Figure 4.5 is a two-parameter plot of Equation 4.7 for values of $T_c$, $T_B$, and $P_c$ that are representative of hydrocarbons. The negative acentric factor range ($\omega = -0.236$) for hydrogen has not been included in the graph, although Equation 4.3 applies equally well in this region.

Values of $\omega$ were estimated by Equation 4.7 for the substances listed in Tables 4.1 and 4.2. These $\omega$ values (identified as Method II) are compared with those found by the definition (Method I). The differences are small in most cases.

**Application to Mixtures.** Compressibility factors for mixtures have long been estimated from correlations of z as a function of $T_r$ and $P_r$, using pseudocritical temperatures and pressures for computing the reduced conditions.

There is no reason to doubt that a similar mixture calculation could be made with the improved compressibility factor correlation, using the acentric factor. Molar average $\omega$ values, as well as molar average critical constants, could be used in the application. Alternatively, molar average critical conditions and molar average boiling point could be used in Equation 4.7 or Figure 4.5 to find the acentric factor for a mixture.

In applying this method in either way, the mixture is treated as a hypothetical single component. The single value of $\omega$ used for the mixture is an "equivalent component" property in the same way the pseudocritical conditions define the mixture. However, as the application of this theorem of corresponding states to mixtures has not yet been tested, no definite conclusions can be reached or recommendations made.

**Critical Density.** The high temperature-low density end of the saturated liquid density-versus-temperature curve is fixed by the critical point. For a hydrocarbon mixture or a petroleum fraction, this critical density may be estimated from the molecular weight, the critical temperature and pressure, and the critical compressibility factor. The equation is obtained as follows:

$$P_cV_c = z_cRT_c$$

$$\rho_c = \frac{P_c}{z_cRT_c} = \frac{144}{(1544)\ (7.48)}\frac{P_cM}{z_cT_c} \qquad (4.8)$$

$$\rho_c = 0.0125\frac{P_cM}{z_cT_c}$$

where $\rho_c$ = critical density, pounds/gallon
$P_c$ = critical pressure, psia
$T_c$ = critical temperature, °F
$z_c$ = critical compressibility factor
M = molecular weight

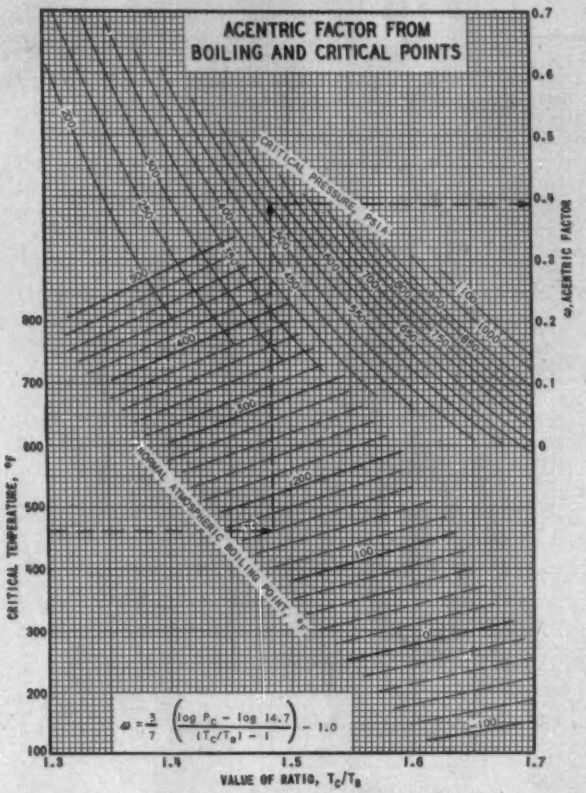
ACENTRIC FACTOR FROM
BOILING AND CRITICAL POINTS
CRITICAL PRESSURE, PSIA
NORMAL ATMOSPHERIC BOILING POINT, °F
CRITICAL TEMPERATURE, °F
ω, ACENTRIC FACTOR
VALUE OF RATIO, $T_c/T_b$
$\omega = \frac{3}{7}\left(\frac{\log P_c - \log 14.7}{(T_c/T_b) - 1}\right) - 1.0$

**FIGURE 4.5—Acentric factor from boiling and critical points.**

Values of $P_c$, $T_c$, and M may be found from empirical correlations employing gravity, average boiling point, and/or UOP "K" as parameters.

The critical compressibility factor, $z_c$ may be found from Pitzer's values of $z^\circ$ and $z'$ at the critical point. At $T_r = 1.0$ and $P_r = 1.0$, $z^\circ = +0.291$ and $z' = -0.080$ (Figure 4.1). Substitution of these values into Equation 4.2 and combining with Equation 4.7 gives the following general relationship for $z_c$:

$$z_c = 0.371 - 0.0343\left(\frac{\log \frac{P_c}{14.7}}{\frac{T_c}{T_b} - 1}\right) \qquad (4.9)$$

Equation 4.9 should be valid for petroleum fractions, as well as hydrocarbon mixtures. In addition to giving the value of $z_c$, Equation 4.9 permits the calculation of $P_c$. Values of $z_c$ from Equation 4.9 might be useful in applying Lydersen, et al., tables to mixtures.

**Recent Equation of State Developments.** As pointed out in Part 2, P-V-T data are also correlated by analytical equations of state developed empirically by finding the constants or coefficients required to make the desired expression fit the available experimental data. This previous discussion was illustrated with the simpler equations of state. More rigorous equations and recent developments in this application are of interest.

No discussion of P-V-T data and equations of state would be complete without the Beattie-Bridgeman and the Benedict-Webb-Rubin equations of state. The Beattie-Bridgeman 5 constant equation of state is discussed because it is the most rigorous equation that has been generalized. The Benedict-Webb-Rubin, 8 constant equation of state is discussed because of its greater accuracy and its wide usage. The more recent equations of Pings and Sage[8] and of Martin and Hou[5] are also discussed to bring the subject up to date.

**Beattie-Bridgeman Equation.** This equation uses five empirical constants and has been put into generalized form.[11] The three forms of the B-B equation of state follow

$$P = \frac{RT(1-\varepsilon)}{V^2}(V+B) - \frac{A}{V^2} \qquad (4.10)$$

where:

$$A = A_o\left(1 - \frac{a}{V}\right)$$

$$B = B_o\left(1 - \frac{b}{V}\right)$$

$$\varepsilon = \frac{c}{VT^3}$$

the five empirical constants being: $A_o$, $B_o$, a, b, and c.

The generalized form is:

$$P_r = \frac{T_r(1-\varepsilon')}{(V_r')^2}(V_r' + B') - \frac{A'}{(V_r')^2} \qquad (4.11)$$

where:

$$A' = 0.4758\left(\frac{1 - 0.1127}{V_r'}\right)$$

$$B' = 0.1867\left(\frac{1 - 0.03833}{V_r'}\right)$$

$$\varepsilon' = \left(\frac{0.050}{T_r^3 V_r'}\right)$$

as previously

$$V_r' = \frac{V}{RT_c/P_c}$$

Equation 4.10 may be arranged in another form by combining with the three relationships for the constants, i.e.,

$$\frac{PV}{RT} = z = 1 + \left(B_o - \frac{A_o}{RT} - \frac{c}{T^3}\right)\frac{1}{V} + \left(-B_o b + \frac{A_o a}{RT} - \frac{B_o c}{T^3}\right)\frac{1}{V^2} + \left(\frac{B_o b c}{T^3}\right)\frac{1}{V^5} \qquad (4.12)$$

The Beattie-Bridgeman equation of state is reliable up to the critical density but not beyond. Therefore, it is not applicable to the liquid phase.

**Benedict-Webb-Rubin Equation.** The BWR equation is widely used. In this equation of state, pressure is ex-

pressed as a function of density (reciprocal volume) and temperature. The form of the equation is a power series ending with an exponential density term. The coefficients of the density terms are function of temperature. There are eight empirical constants for each substance, which makes it more accurate. Pressure is the following function of temperature and density, d:

$$P = RTd + \left(B_oRT - A_o - \frac{C_o}{T^2}\right)d^2 + (bRT - a)d^3 + a\alpha d^6 + cd^3\frac{(1+\gamma d^2)}{T^2}\exp(-\gamma d^2) \qquad (4.13)$$

where $B_o$, $A_o$, $C_o$, b, a , c, $\gamma$ and $\alpha$ are empirical constants for each substance from experimentally determined P-V-T, critical, and vapor pressure data. The BWR equation of state does very well up to about twice the critical density. Above that it is not satisfactory. In using this equation to compute thermodynamic properties, it is considered best to employ a pressure residual (difference between observed and equation values of pressure) to take full advantage of experimental data. This residual is treated graphically.

The BWR equation of state may also be written

$$z = 1 + \left(B_o - \frac{A_o}{RT} - \frac{C_o}{RT^2}\right)d + \left(b - \frac{a}{RT}\right)d^2 + \frac{a\alpha}{RT}d^5 + \frac{cd^3}{RT^3}(1+\gamma d^2)\exp(-\gamma d^2) \qquad (4.14)$$

The BWR equation of state is the technique being used in the API 44 P-V-T data compilation.[3] This equation of state has been fitted to 15 hydrocarbons and has been used to compute thermodynamic properties, such as entropies and enthalpies, for single-component systems. The BWR equation of state has been applied to mixtures by combining the individual component constants to get constants for mixtures. In this way a mathematical basis for predicting phase behavior, as well as volumetric and thermal properties, has been developed.

The BWR equation of state constants have been combined as follows for mixtures:

$$B_o = \Sigma x_i B_{oi} \qquad b = [\Sigma x_i (b_i)^{1/3}]^3 \qquad \alpha = [\Sigma x_i (\alpha_i)^{1/3}]^3$$
$$A_o = [\Sigma x_i (A_{oi})^{1/3}]^3 \qquad c = [\Sigma x_i (c_i)^{1/3}]^3 \qquad a = [\Sigma x_i (a_i)^{1/3}]^3$$
$$C_o = [\Sigma x_i (C_{oi})^{1/3}]^2 \qquad \gamma = [\Sigma x_i (\gamma_i)^{1/3}]^2$$

These mixing relationships are adequate for some mixtures, but are oversimplifications for others.

Three recent papers[1,2,7] deal with applications of the Benedict equation of state. Canjar et al.[2] correlated the eight equation of state constants with the critical temperature. For many vapor phase applications, this should be satisfactory; but it is unlikely that it is suitable for liquid phase applications.

In another paper Canjar[1] discussed the limitations of mixing rules for equation of state constants. Kay's pseudocritical (i.e., molal average of $T_c$ and $P_c$) reduced parameters for applying generalized compressibility factor correlations to mixtures is one such mixture rule. Another is the equation of state constant combinations proposed by Benedict and shown above.

Canjar[1] pointed out that these mixing rules are equivalent to regarding the mixture as an average hypothetical component, which might be identical to an actual intermediate component of the mixture. Applying the equations of state, via the mixture rules, to the mixing of this actual intermediate component and the equivalent average component would show no volume or heat change.

On the improbability of this occurring, it was concluded[1] that the mixture rules are invalid for mixtures of more than two components. In spite of their limitations, these mixture rules are useful in engineering calculations.

**Other Equations of State.** Martin and Hou[5] proposed the following modified form of the virial equation:

$$P = \frac{RT}{V-b} + \frac{A_o + B_oT + C_o\exp(-5.475\,Tr)}{(V-b)^2} + \frac{A_o + B_o + C_o\exp(-5.475\,Tr)}{(V-b)^3} + \frac{A_4}{(V-b)^4} + \frac{B_oT}{(V-b)^5} \qquad (4.15)$$

The variable $(V-b)$ is used instead of V and exponential terms are used. Ten constants, including the critical temperature, are used in the Martin-Hou equation.

Opfell, et al.[7], generalized the Benedict equation of state and applied this reduced form to values of $z^o$ and $z'$ in Equation 27.2. This required 14 constants plus the acentric factor and the exponential coefficient to predict compressibility factors.

More recently, Pings[8] developed an orthogonal polynomial equation of state that is open ended and can be truncated at whatever point yields an acceptable approximation. Fitting the equation to data and applying it to problem solving is said to be more convenient because of the orthogonal polynomial form. The full length of the equation may be applied to the liquid phase and a truncated form used for fitting the vapor phase. As yet, no applications have been made to mixtures.

ACKNOWLEDGMENT

W. S. Hanna made the charts.

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**Next: Part 5. Thermal Expansion Factors for Petroleum.**

## Know Your Asphalts—Part 8

# Use These Tests for Roofing Asphalt

**Roofing asphalts require additional tests such as spot, stain, Fraas break-point and pliability.**

**E. J. Barth**
Asphalt Consultant, New York City

PARTS 5 AND 6 discussed the tests commonly made on paving and roofing asphalts. Certain special tests are used in an empirical way in the roofing industry. These are:—spot test, stain tests, pliability tests and others.

**Spot Test (Oliensis Test)** was originally developed to prove quite conclusively the presence of carbonaceous matter derived from cracking coil tars or residua. It has also been found valuable in detecting the sensitiveness of asphalt undergoing steam or vacuum reduction. The test is valuable here in controlling still temperatures during reduction so as to avoid hydrocarbon rearrangement under heat conditions. Such rearrangement is not due to splitting or cracking reactions. Some investigators have pointed to high boiling waxes and ceresins as splitting easily at reduction temperatures and giving a spot test which is "positive." (See Part 6 for a description of the procedure used in making the spot test.) The presence of cracked asphalts is clearly indicated by an intense carbon like inner spot, surrounded with a lighter halo of migrated oily constituents.

**Stain Tests** are now standardized by the A.S.T.M. and are most commonly made on blown roofing asphalts. They originated when roofers noticed certain asphalts forming stains on the roofing felts or striking through an outer coating of high melting point blown asphalt from below where a softer and lower melting point saturant is normally used.

The stain test should prove valuable not only in the roofing industry, but also for paving asphalts of the synthetic type where:

- Aging has taken place after many years of road service,
- Asphalts are being stored for long periods of time,
- And, also as an adjunct to the Oliensis spot test.

The heterogeneity of asphalts requires further intense research efforts and the desire of the manufacturer and user alike to find a reliable test that is as scientific as possible.

The stain tests consists of placing a known amount of asphalt in standard moulds with 31 sheets of standard cigarette paper superimposed. After preparation, the apparatus is placed in a constant temperature oven for 18 hours at 210 F. under an inert gas pressure of 50 pounds per square inch. After exposure, the papers are separated and placed in a viewing box illuminated with ultraviolet light of 3000-4000 angstrom units. The presence of oily stains on the various papers is noted and calculations made.

This test is usually made on asphalts of over 150 F. melting point and harder than the usual paving asphalt cements. It is valuable for indicating how well the asphalt constituents are held together in the asphalt. That is, to what degree has their mutual solubility in one another been disrupted or destroyed.

It is known that many asphalts may contain hydrocarbons not compatible with the high molecular weight asphaltenes. Even if compatible, some physical change or agency may change the equilibrium (such as oxidation) toward degrees of insolubility of the asphaltenes. This gradual change causes the oily constituents to "ooze out" of the asphalt by a process of sweating. This leaves behind in the mass a less homogeneous material, more crumbly, or becoming so, and quite devoid of adhesiveness, body and proper texture. Samples have been known giving a slightly adverse stain test that eventually after storage of a year or so, spontaneously broke down into a crumbly dry mass, under touch. The sample carton showed heavy saturation of brownish oil.

**Fraas Break-Point Tests** have connection with paving or road behavior of an asphalt. Lowest possible breaking points consistent with asphalt manufacture are desired. Average Fraas test on paving asphalt of Mexican origin is approximately plus 10 to 18 (85-100 P.). The blown asphalts show lower values at similar penetration. Fraas breaking point tests are also made abroad on paving asphalts.

**Pliability Tests** are usually required by the user of roofing asphalts. They consist of bending small slabs of asphalt over mandrels at low temperatures. Also the roofing felt with or without coating is tested for pliability. Numerous tests are applied to determine pliability.

The property of pliability, brittleness and similar physical tests have occupied asphalt technologists for many years.

**Part 9 will appear in an early issue.**

# Figure Cost of Getting Octanes

**Refining processes commercially available now will satisfy the octane demand for the next five years, but the cost will be much greater. Here is a way to figure how much.**

**W. J. Service, R. E. Payne, and W. E. Askey**
The Pace Company, Houston

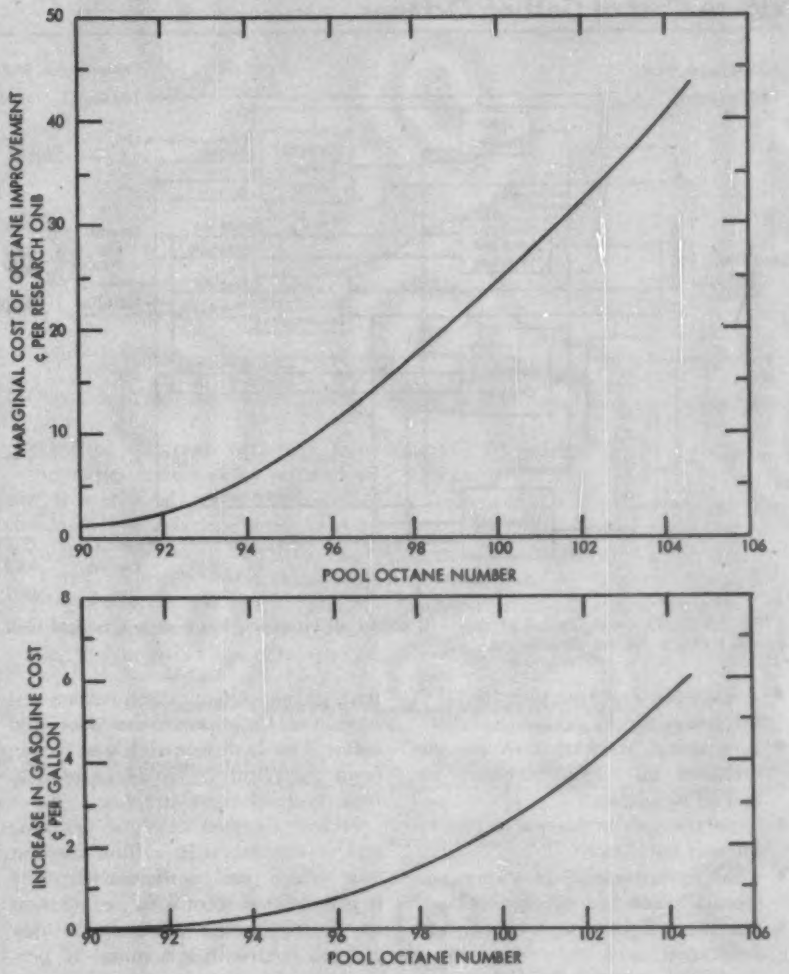


**FIGURE 1—The price of gasoline must be increased to help pay for the investment in octane improving processes.**

MOTOR GASOLINE octanes recently have approached levels where the last increment of octane improvement costs as much to produce as today's market prices will permit. The rapid increase did not cause undue strain on most refiners before because economical octane-producing processes were available. It is important today, however, that the refiner operate his conversion units at their most efficient levels. It is even more important that the refiner recognize the probability of future octane increases in order to plan for future capital expenditures.

Conclusions from this study:

- A typical Gulf Coast refiner can produce motor gasoline with predicted octane quality requirements (104.5 and 97.5 Research octane for premium and regular, respectively) through 1963 using presently available commercial processes.
- Significant capital expenditures will be required, but they can be spread over the period.
- With the present trend in gasoline octane numbers, the price of gasoline must go up. Continued increases in engine compression ratio and the resultant increases in gasoline octane number will raise the cost of manufacturing regular gasoline by over 1 cent per gallon and premium by some 4 to 5 cents per gallon between now and 1963. Figure 1 reports the cost increase for various octane levels.

**Basis for Calculations.** The complexities of modern refineries make it impossible to calculate one set of octane improvement costs which can be used by all refiners for all refining conditions. In order to illustrate the method of calculation, it was necessary to start from an operating refinery. The authors arbitrarily selected a Gulf Coast location for the refinery and assumed that it would charge 50,000 barrels per calendar day of West Texas sour crude and produce only major fuel products. We selected process equipment for the existing refinery which approximates that in an average Gulf Coast refinery today with only enough octane producers to manufacture today's gasoline. A block flow diagram for this refinery is shown in Figure 2. Processing units consist of the following:

- A two-stage crude distillation unit
- A naphtha desulfurization and catalytic reforming unit charging all of the 200 to 375F. virgin naphtha

## Figure Cost of Getting Octanes . . .

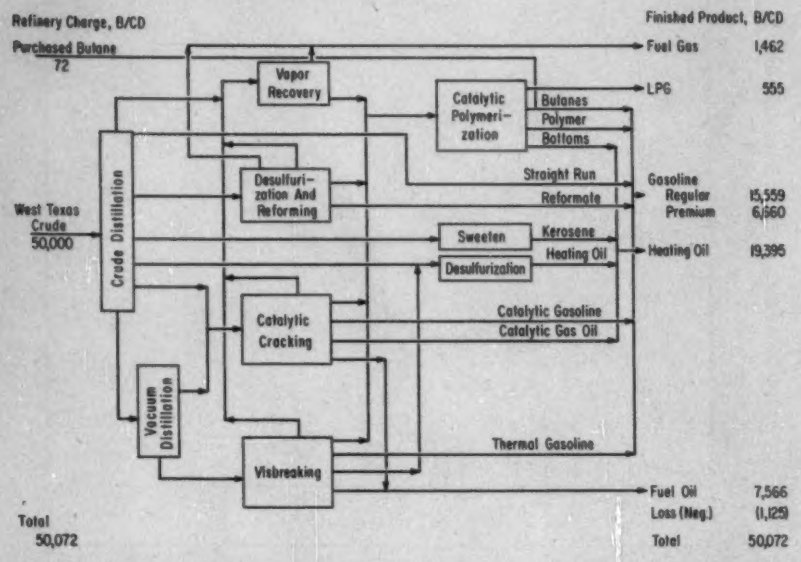


**FIGURE 2—One calculation of cost will not fit all refineries, but here is a typical Gulf Coast refinery for an illustration.**

- A catalytic cracking unit for all of the heavy virgin gas oil
- A thermal cracking unit for visbreaking all virgin residuum for fuel oil reduction
- Catalytic polymerization of propylene and butylenes
- Mild hydrotreating of virgin and thermally cracked middle distillates
- Necessary light ends recovery and distillation units

Choice of a sour crude charge to the refinery necessitates the additional units for catalytic reformer feed desulfurization and the mild hydrotreating of middle distillates. It was assumed that the sulfur level of the naphtha charge to the catalytic reformer must be reduced to below .01 weight percent to avoid corrosion and catalyst deactivation problems. In order to stay competitive quality-wise on the middle distillates, those produced from sour crude must be hydrotreated to reduce sulfur content, to reduce Conradson carbon residue and to improve the odor and color. The hydrogen-rich gas stream from the reformer would be used to treat both of these streams.

It was assumed catalytic cracking was accomplished in a fluid catalyst unit which had sufficient capacity to give a 55 percent 430F. conversion on 20,000 barrels per stream day of fresh feed with a nominal 10 percent recycle.

A summary of the product distribution from this current refinery is shown in Table 1. In all cases 30 percent of the gasoline was blended as premium quality.

The product prices are representative Gulf Coast low cargo quotations as of January, 1958. It was assumed the refinery produced all of its steam requirements and generated most of its power requirement. These prices are given in Table 2.

**Prediction of Future Quality.** The motor gasoline quality which has exhibited the greatest increase over the years is the octane number. During the past 20 years the actual performance of a gasoline in a given car has been most closely approximated in the laboratory by measurement of the Research octane number. For this reason most refiners blend gasoline with Research octane number as the prime consideration.

The use of more automatic high-speed transmissions in new cars has caused the laboratory Research octane number to differ markedly from the road performance when the gasoline sensitivity (F-1 minus F-2) is high. Since sensitivity fluctuates widely with gasoline produced in different processing units, an evaluation of road octane is equally as important as Research octane. A method of predicting road octane numbers from the laboratory Research and Motor octane numbers was suggested by E. S. Corner.[1] He presents the following equation:

$$\text{Road Octane Number} = m_1\,(\text{F-1}) + m_2\,(\text{F-2}) + C$$

Where $m_1$, $m_2$ and C are constants for a specific engine

DuPont[2] suggests that the coefficients for Research and Motor octane numbers to be used in the same type of equation should be 0.5. They present the following relationship between road and laboratory octane numbers:

$$\text{Road Octane Number} = 0.5\,(\text{F-1}) + 0.5\,(\text{F-2}) + 4.5$$

Esau, et al,[3] suggests that the road octane number be related to laboratory octanes and fuel composition. We did not develop sufficient component information in this study to utilize this approach. The formula presented by DuPont was used in this paper because of the simplicity with which road octanes could be obtained from Research and Motor ratings.

To simplify the mechanics of predicting future octane number requirements, it was assumed that Research octane numbers would be satisfactory as long as the gasoline depreciation

**TABLE 1**
**Base Refinery, Product Distribution**

| Product | BPCD |
|---|---|
| Fuel Gas (FOE) | 1,462 |
| LPG | 555 |
| Regular Motor Fuel | 15,559 |
| Premium Motor Fuel | 6,660 |
| Heating Oil | 19,395 |
| Fuel Oil | 7,566 |
| Loss | —1,125 |
| Total Products | 50,072 |
| **Feed** | |
| West Texas Sour Crude | 50,000 |
| Purchased Butane | 72 |
| Total Feed | 50,072 |

**TABLE 2**
**Price Structure**

| | |
|---|---|
| Premium Motor Fuel | 13.0¢/gallon |
| Regular Motor Fuel | 11.0¢/gallon |
| Heating Oil | 9.0¢/gallon |
| LPG | 4.0¢/gallon |
| Isobutane | 8.0¢/gallon |
| Normal Butane | 5.0¢/gallon |
| Fuel Oil | $2.60/barrel |
| Fuel Gas | 15¢/MMBtu |
| Purchased Power | 0.8¢/KWH |
| Makeup Water | 3¢/M gallons |
| TEL | 0.21¢/cc |

**TABLE 3**
**Motor Gasoline Research (F-1) Octane Number***

| Year | Regular | Premium | Pool |
|---|---|---|---|
| 1957 (Base) | 90.0 | 98.0 | 92.4 |
| 1958 | 91.0 | 99.0 | 93.4 |
| 1959 | 92.5 | 100.5 | 94.9 |
| 1960 | 94.0 | 102.0 | 96.4 |
| 1961 | 95.0 | 103.0 | 97.4 |
| 1962 | 96.3 | 104.0 | 98.6 |
| 1963 | 97.5 | 104.5 | 99.6 |

* Numbers over 100 are on the ASTM scale.

(Research minus Road octane number) did not exceed two units.

Research octane numbers increased at a rate of nearly one number per year until 1953.[4] At that time a sharp increase in the compression ratios of new cars required octane increases of from 1.5 to 2 numbers per year. There have been many predictions of the future octane requirements of motor gasolines.[2,5,6,7] It is interesting to note that predictions made 3 or 4 years ago were consistently low in the light of present experience. The most recent predictions have extrapolated octane requirements at the rate of 1.5 to 2 octane numbers per year. The inherent discrepancies in predicting future gasoline qualities are recognized but such a prediction must be made to enable determination of the gasoline processing which may be required in the next few years. For the purposes of calculating the cost of increasing octane numbers in this study, the quality predictions summarized in Table 3 have been prepared.

This prediction was prepared by extrapolating compression ratios of new model cars as shown in Figure 3. Compression ratio is probably the most important engine characteristic in establishing the fuel octane requirements. However, engines with the same compression ratio may well require different octane quality fuels. As reported by Caris, et al,[8] some cars may have more mechanical octane numbers built in than others. Chandler and Enoch[9] showed that one engine can appreciate commercial fuels more than other engines. Appeldoorn[10] suggests that different requirements result from the engine's digestive ability (amount of deposit formation.) We have predicted the relationship shown in Figure 4; 90 percent of the cars with the same compression ratio will be satisfied by the Research octane number fuel shown. These relations were used to predict the values reported in Table 3. The premium gasoline should satisfy 90 percent of the new model cars with maximum compression ratios while the regular gasoline should satisfy 70 percent of all the cars on the road.

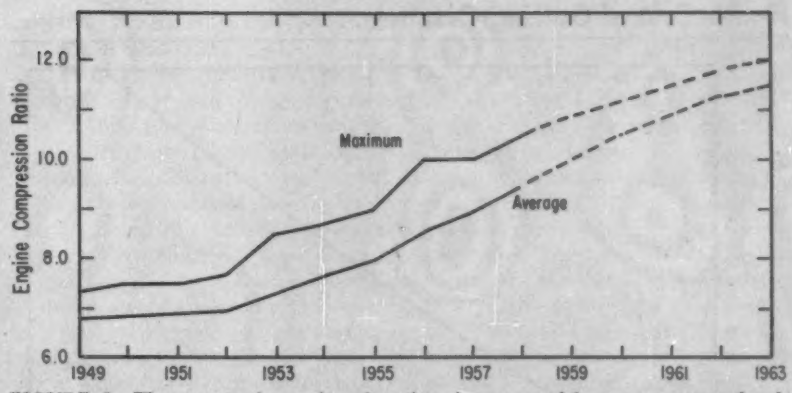

**FIGURE 3—The compression ratios of engines in new model cars are extrapolated.**

Past variations in motor gasoline volatilities have been examined to determine the trend, if any, in this important gasoline quality. The most significant changes have occurred in the Reid vapor pressure and 10 percent distilled points. Vapor pressures

**TABLE 4—Processing Changes and Capital Investments**

| Year | Process Additions | Process Changes | Capital Investment |
|---|---|---|---|
| 1957 | | Base | |
| 1958 | None | Increase reforming severity from 85 to 92 F-1 clear | None |
| 1959 | Revamp Reformer | Lower cat. reformer pressure from 500 to 350psig. Raise severity to 96 F-1 clear | $ 100,000 |
| 1960 | Fractionation Equipment | Segregate light cat. naphtha and heavy reformate into premium. Hvy. cat. naphtha and light reformate into regular | $ 650,000 |
| 1961 | Sulfuric Acid Alkylation | Shut down cat. poly. and alkylate all $C_3^=$ and $C_4^=$. Raise reforming severity from 96 to 98 F-1 clear | $3,150,000 |
| 1962 | Dependanizer, Hydrodesulfurization and Cat. Reformer for light virgin naphtha and thermal naphtha | Dependanize $C_5$-200 F. naphtha, hydrodesulfurize and reform in admixture with thermal naphtha. Run at 76 F-1 clear. | $3,300,000 |
| 1963 | Pentane Isomerization | Isomerize all the pentanes. Increase light naphtha reforming severity from 76 to 83.5 F-1 clear | $1,100,000 |
| | Total | | $8,300,000 |

**TABLE 5—Motor Gasoline Pools—By Years (BPCD)**

| Motor Gasoline Component | 1957 (Base) | | 1958 | | 1959 | | 1960 | | 1961 | | 1962 | | 1963 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reg. | Prem. | Reg. | Prem. | Reg. | Prem. | Reg. | Prem. | Reg. | Prem. | Reg. | Prem. | Reg. | Prem. |
| Cat. Naphtha | 4,120 | 3,330 | 4,079 | 3,371 | 6,916 | 534 | 5,626 | 1,824 | 5,213 | 2,237 | 6,760 | 690 | 7,450 | .... |
| Mixed Alkylate | .... | .... | .... | .... | .... | .... | .... | .... | 172 | 2,818 | 172 | 2,818 | 172 | 2,818 |
| Cat. Polymer | 278 | 862 | .... | 1,140 | .... | 1,140 | .... | 1,140 | .... | .... | .... | .... | .... | .... |
| Virgin $C_5$-200F | 4,300 | .... | 4,300 | .... | 4,300 | .... | 4,300 | .... | 4,300 | .... | 1,100* | .... | 594** | 496** |
| Thermal Naphtha | 811 | .... | 811 | .... | 811 | .... | 811 | .... | 811 | .... | .... | .... | .... | .... |
| Cat. Reformate | 4,840 | 1,573 | 4,917 | 1,488 | 2,129 | 4,186 | 3,375 | 2,940 | 4,816 | 1,334 | 7,087 | 2,673 | 6,543 | 2,816 |
| Butane | 1,210 | 595 | 1,123 | 561 | 994 | 690 | 1,002 | 606 | 1,406 | 641 | 1,124 | 779 | 1,015 | 670 |
| Total | 15,559 | 6,660 | 15,230 | 6,560 | 15,150 | 6,550 | 15,114 | 6,510 | 16,718 | 7,030 | 16,243 | 6,960 | 15,774 | 6,800 |
| FEL, cc/gallon | 1.22 | 3.00 | 1.08 | 3.00 | 1.54 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| F-1 ON | 90.3 | 98.3 | 91.3 | 99.3 | 92.8 | 100.8 | 94.3 | 102.3 | 95.3 | 103.3 | 96.6 | 104.3 | 97.7 | 104.7 |
| T-2 ON | 81.9 | 86.4 | 82.5 | 86.8 | 82.9 | 90.1 | 85.5 | 89.5 | 86.5 | 94.3 | 87.1 | 98.0 | 87.4 | 100.5 |
| Calculated Road ON | 90.6 | 96.9 | 91.4 | 97.6 | 92.4 | 99.9 | 94.4 | 100.4 | 95.4 | 103.3 | 96.3 | 105.6 | 97.1 | 107.1 |
| Pool F-1 ON | 92.7 | | 93.7 | | 95.2 | | 96.7 | | 97.7 | | 98.9 | | 99.8 | |
| Pool F-2 ON | 83.2 | | 83.8 | | 85.0 | | 86.7 | | 88.8 | | 90.4 | | 91.3 | |

* Mixed Pentanes.
** Isomerized Pentanes.

## Figure Cost of Getting Octanes . . .

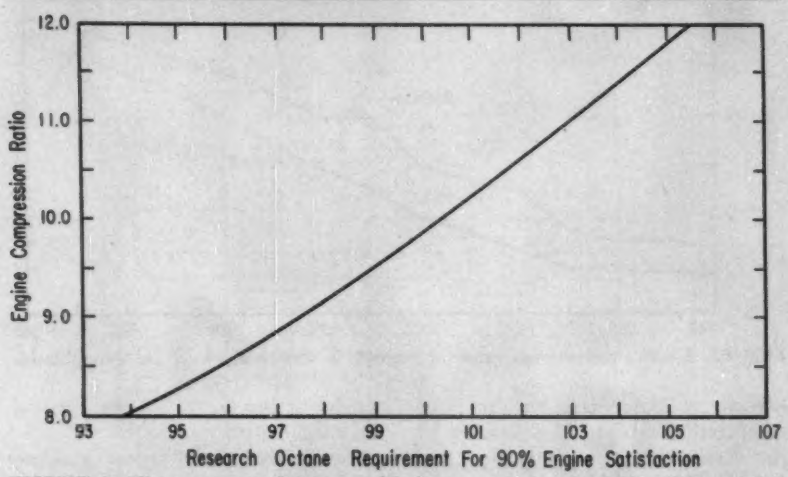


**FIGURE 4—Ninety percent of the cars with the same compression ratio will be satisfied by the F-1 octane number fuel represented here.**

have increased while the 10 percent points have decreased.[4] It was concluded that the average gasoline (winter and summer) will have an RVP of over 10 pounds and the average 10 percent distilled point will be less than 125F.

**Process Changes**—Table 4 summarizes the process changes and process additions chosen as the most economical method for meeting each year's octane requirements. The calculation techniques employed to develop this sequence of changes and additions are described in an accompanying section. Table 5 shows the components which make up the regular and premium gasoline anticipated for the years 1958 to 1963. The Research and Motor octane numbers are shown with the calculated Road octane numbers.

The increase in octane number predicted for 1958 can be met by increasing the catalytic reforming severity from 85 F-1 clear (95.5 @ 3 cc Tel/gal) to 92 F-1 clear (98.9 @ 3 cc Tel/gal). In 1959, the octane requirement can be met with a capital expenditure of $100,000 for revamping the reformer to allow operations at an average reactor pressure of 350 psig. It is also necessary to raise reforming severity to produce a 96 F-1 clear (101.0 @ 3 cc) reformate to manufacture gasoline with the predicted qualities.

It is possible to produce enough Research octane number for the 1960 gasoline pool without further increasing reforming severity. However, even though pool octanes are not a limitation, sufficient components are not available for premium gasoline blending. Fractionation of the catalytic naphtha and reformate streams will permit blending the high octane portion of each stream into premium gasoline with the remainder directed to regular gasoline. The estimated cost of this fractionation equipment is $650,000.

In the 1960 pool the Road octane of the premium gasoline was 1.9 units below the Research octane number. Even though the F-1 should match competition, the poor Road number would cause a lower percent car satisfaction than desired. We decided to add alkylation for the 1961 pool to provide Motor as well as Research octane numbers. If an alkylation plant is built, adding sufficient capacity to process propylenes as well as butylenes is justified. Examination of the following octane numbers reveals the Road octane advantage of alkylation over polymerization:

| Product | @ 3cc TEL/Gal F-1 | @ 3cc TEL/Gal F-2 | Calculated Road ON* |
|---|---|---|---|
| Mixed Light Polymer.. | 101 | 86 | 98.0 |
| Mixed Light Alkylate.. | 103 | 104 | 108.0 |

* Road ON = 0.5 (F-1) + 0.5 (F-2) + 4.5.

The cost of this alkylation plant is estimated at $3,150,000. It is also necessary to increase the reformer severity to its maximum level of 98 F-1 clear (102.4 @ 3 cc).

The only low octane streams remaining in motor gasoline in the 1961 pool are the $C_5$ to 200 F. virgin naphtha and the thermal naphtha. It is possible to depentanize, hydrodesulfurize and catalytically reform these stocks in admixture. Octane production by this method is more expensive than volume reforming the 200-375F., but in this particular case is the least expensive of the remaining commercially available processes. The equipment would cost $3,300,000.

**TABLE 6—Incremental Products by Years—1957-1963**

| Change from Year/Year | CHANGES IN PRODUCTION, B/CD '58/'57 | '59/'58 | '60/'59 | '61/'60 | '62/'61 | '63/'62 | '63/'57 |
|---|---|---|---|---|---|---|---|
| Motor Gasoline | (429)* | (90) | (76) | 2,124 | (545) | (629) | 355 |
| Normal Butane | 81 | 7 | 35 | (1,320) | 238 | 373 | (586) |
| Isobutane | 78 | 1 | 41 | (1,157) | 62 | 74 | (901) |
| LPG | 46 | (17) | .... | (84) | 62 | 74 | 81 |
| Fuel Gas | 229 | 78 | .... | 86 | 207 | 165 | 765 |
| Loss | (5) | 21 | .... | 351 | (24) | (57) | 286 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cost of Product Changes, $/CD | 1,266 | 349 | 140 | (3,111) | 1,523 | 1,609 | 1,776 |

* Volumes in parentheses are negative.

**TABLE 7—Incremental Cost of Octane Improvement by Years—1957-1963**

| Cost Increase from Year/Year | COSTS IN $/CD '58/'57 | '59/'58 | '60/'59 | '61/'60 | '62/'61 | '63/'62 | '63/'57 |
|---|---|---|---|---|---|---|---|
| Incremental Products (see Table 6) | 1,266 | 349 | 140 | (3,111) | 1,523 | 1,609 | 1,776 |
| Operating Costs | | | | | | | |
| Reforming Severity | 305 | ..... | ..... | 150 | ..... | ..... | 455 |
| TEL | (250) | 604 | 1,931 | 562 | (144) | (166) | 2,537 |
| Component Segregation | ..... | ..... | 623 | ..... | ..... | ..... | 623 |
| Alkylation | ..... | ..... | ..... | 2,700 | ..... | ..... | 2,700 |
| New Reformer | ..... | ..... | ..... | ..... | 2,300 | ..... | 2,300 |
| New Reformer Severity | ..... | ..... | ..... | ..... | ..... | 400 | 400 |
| Isomerization | ..... | ..... | ..... | ..... | ..... | 1,100 | 1,100 |
| Sub-total | 55 | 604 | 2,554 | 3,412 | 2,156 | 1,334 | 10,115 |
| Return on New Investment, 40%/yr. | ..... | 110 | 712 | 3,452 | 3,616 | 1,206 | 9,096 |
| Total Incremental Costs | 1,321 | 1,063 | 3,406 | 3,753 | 7,295 | 4,149 | 20,987 |
| Total Gasoline Pool for each Year, BPCD | 21,790 | 21,700 | 21,624 | 23,748 | 23,203 | 22,574 | 22,574 |
| Incremental Cost of Octane Improvement, ¢/gal | 0.14 | 0.12 | 0.38 | 0.38 | 0.75 | 0.44 | 2.21 |

Reforming severity of 76 F-1 clear (94.6 @ 3 cc would be required to meet 1962 octane requirements.

For 1963, the pentanes must be isomerized and the light naphtha reformer operated at 83.5 F-1 (97.3 @ 3 cc) severity. Cost of the fixed bed isomerization unit would be $1,100,000.

The total capital investment required over the next six years to produce motor gasoline having the necessary octane numbers is $8,300,000. This investment and the associated increased operating costs must be paid for by the motorist who purchases the gasoline. The increased cost involved in manufacturing gasoline of high octane number is a subject which has been discussed previously but not always definitively. The results of this study have been used to show how manufacturing costs of gasolines can rise as octane levels continue to increase.

Tables 6 and 7 summarize the total costs (product and operating costs and a 40% annual return on new investment) required for each annual increment of octane improvement. These costs were used to calculate a marginal cost of octane improvement for each increment of improvement. The marginal cost of Research octane number was plotted versus the octane number at which each cost was applied. A smooth curve drawn through these points is shown in the upper portion of Figure 1 which is, therefore, a plot of marginal cost of octane improvement as a function of the octane number of the gasoline produced in a typical refinery.

The lower portion of Figure 1 shows the increase in gasoline manufacturing cost as a function of octane level. It may be noted that this curve shows that gasoline manufacturing costs increase quite slowly up to about 96 octane but that costs then rise at a more rapid rate with further increase in octane level. The slight increase in manufacturing cost at low octane numbers is one reason that gasoline prices have risen so little in past years. The curve shows also that as regular gasoline is raised from 90 to 97.5 Research octane that the cost increases by 1.2 cents per gallon while premium gasoline, in going from 98 to 104.5 octane number, will cost some 4.6 cents per gallon more to manufacture. We conclude, therefore, that by 1963 the price of regular gasoline should rise by slightly over 1 cent per gallon and that the spread between regular and premium should increase from the current 2 cents per gallon to about 5½ cents per gallon.

## HOW COST IS CALCULATED

The first step in calculating economics was to establish the base gasoline pool. All of the gasoine pools were blended to the predicted Research octane number with an added blending tolerance of 0.3 F-1 to insure meeting the minimum specifications. The regular gasoline was maintained at 70 percent of the total pool. The various methods of octane production were examined to determine the most economical means of meeting each year's octane requirements. The investigation of octane improvement costs by varying operations of existing equipment was made on an incremental basis using only marginal operating costs. Examples of these costs are adding TEL or increasing reforming severity as shown in Figures 5 and 6. The economics of octane improvement for any new process or for changes in existing processes which required capital expenditures included a 40 percent annual gross return on investment.

The calculation for cost of Research and Road octane number for recycle isomerization of normal pentane in a 98 octane number pool is shown in Table 8 as an example. A similar calculation was made for each potential process or change in operations at each pool octane level. Figures 7 and 8 are plots of the cost of Research and Road octane number improvement by several methods. By the use of such plots, it is possible to define the most economical means of making the next increment of octane number either to raise the level of the entire gasoline pool or to manufacture prime components for blend-

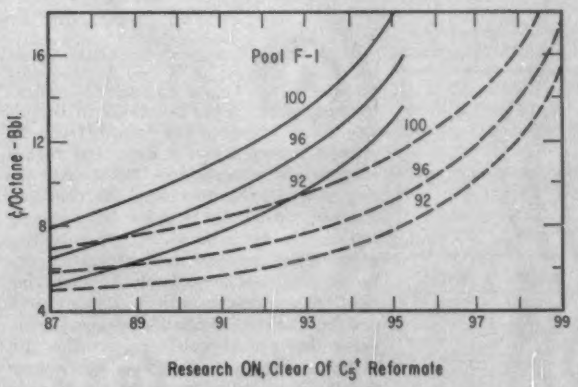


FIGURE 5—The base refinery uses a non-regenerative reforming process operating at 500 psig (solid lines). By reforming at 350 psig (dashed line) it is possible to increase gasoline production and thus decrease the cost of getting octanes.

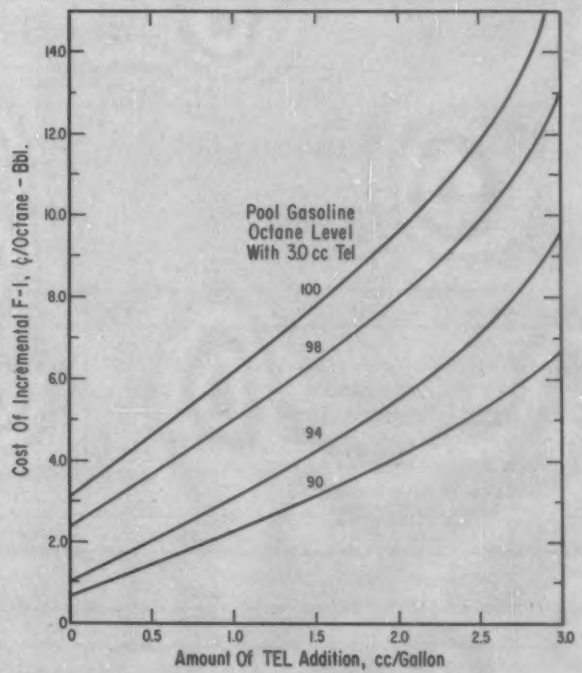


FIGURE 6—As the gasoline pool octane level increases the effectiveness of TEL decreases, thus increasing the cost of octane improvement by TEL addition. The competitive position of other octane producing processes may be established by comparison with these costs.

ing premium gasoline. These figures do not show all of the variables investigated but give only a general idea of the scope and utility of such calculations.

Six octane improvements methods were considered for meeting each year's octane requirements:

**1. Addition of TEL**—The addition of TEL to motor gasoline is recognized as one of the cheapest ways of increasing octane number. However, as the amount of TEL in the gasoline approaches the maximum of 3 cc per gallon, octane increase by this method becomes more costly. Also, as the gasoline pool octane level increases, the effectiveness of TEL decreases, thus increasing the incremental cost of octane improvement by TEL addition. The result of these calculations is summarized in Figure 6. The cost of producing incremental octanes is shown as function of TEL content and pool octane number. In this study the cost of octane improvement by leading varied from 4 to 15 cents/Research octane number barrel. This curve is useful also in determining the TEL and pool octane level at which other octane producing processes become competitive. This figure can be used only for gasolines with the same lead susceptibility as those produced in this hypothetical refinery.

**2. Catalytic Reforming**—The base refinery includes a non-regenerative platinum catalyst reformer charging 200-375 F. virgin naphtha and operating at 500 psig with 10:1 mole ratio of recycle gas to feed. Under these conditions, the maximum reforming severity (as measured by $C_5^+$ reformate octane number) is limited to about 94 F-1 clear (99.9 @ 3 cc) by catalyst deactivation rate. It is possible to calculate material balances and $C_5^+$ reformate motor gasoline qualities at any desired severity up to 94 F-1. A typical material balance is shown in Table 9. When reforming severity is increased, the cost of octane improvement can be calculated by applying product and operating cost debits against the gain in octane quality. Additional operating costs are required for additional utilities and catalyst. This method was employed to calculate the curves shown in Figure 5. As the gasoline pool octane number increases, the cost of reforming for octane improvement increases. Also, as the reforming severity level increases, ¢/F-1 ON Bbl increases.

One way to increase the effectiveness of motor gasoline production by catalytic reforming is to decrease the average reaction pressure.[11] As the pressure decreases, the gasoline yield at constant octane number increases. However, the operating costs at lower pressures are increased because of increased catalyst deactivation by coke formation. Catalyst life can decrease to a point where regeneration is justified. For example, at 350 psig reactor pressure, catalyst regeneration would be required about once every three months.[12] At pressures as low as 200 psig, regeneration might even be required more often than once a week.[13, 14] Choosing the optimum pressure for new reforming capacity can be a very complex problem,[15] but it is possible to calculate the additional product credits resulting from decreased pressure and thereby to determine the optimum pressure.

With the 500 psig-reformer assumed in the base refinery, it is not economically possible to go below 350-psig operations because of the large reduction in recycle gas rates which would result from increased system pressure drop and higher recycle gas compression ratios. At 350 psig it is possible to obtain the increased gasoline production credits by reducing the recycle gas ratio to 7:1 and installing regeneration equipment. Regeneration can be accomplished periodically by modifying existing equipment with a minimum of new equipment installation. Since the regeneration period would require the unit to be off stream for two days every three months, it would be necessary to add some equipment to raise the stream day charge rate by 170 barrels per day in order to maintain the same calendar day rates. We estimate that the cost of these changes will be $100,000. A typical material balance for 350 pound operation is shown as part of Table 9. The incremental cost of producing octane numbers is shown in Figure 5. These costs include a 40 percent return on the $100,000 investment.

Another method of utilizing catalytic

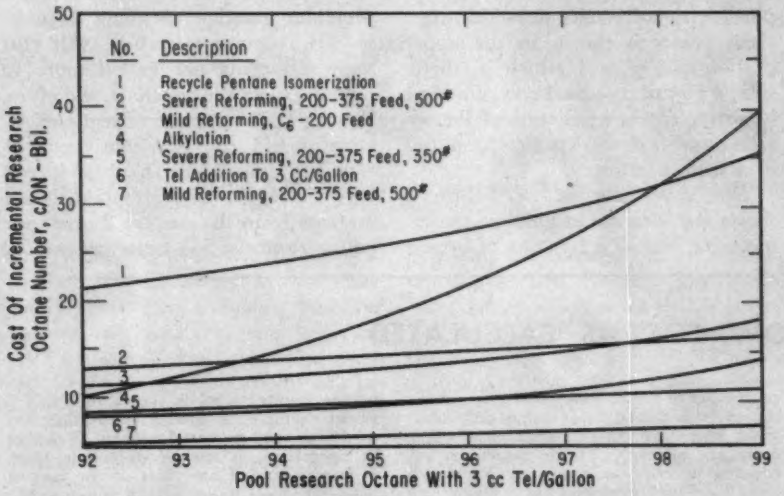


**FIGURE 7—Here is a comparison of costs for F-1 octanes by several methods.**

**TABLE 8—Cost of Octane Improvement by Isomerization**

| Operation | Gasoline Bbls. | RVP | +3 cc TEL RON | +3 cc TEL MON | Fuel Gas | $nC_4$ | Loss |
|---|---|---|---|---|---|---|---|
| Pool | 10,000 | 10.0 | 98.0 | 88.0 | .. | .. | .. |
| Remove Virgin $C_5$'s | (1,100)* | 18.2 | 94.0 | 94.3 | .. | .. | .. |
| Recycle Isomerization | 1,090 | 20.3 | 102.6 | 100.0 | 7 | .. | 3 |
| $nC_4$ to 10 # RVP | (44) | 60.0 | 103.0 | 103.0 | .. | 44 | .. |
| | 9,946 | 10.0 | 98.92 | 88.55 | 7 | 44 | 3 |

△ RONB's = 9,946 (98.92—98.0) = 9,150
△ MONB's = 9,946 (88.55—88.0) = 5,470
△ Road ON Bbls. = 0.5 (9,150) + 0.5 (5,470) = 7,310

**Investment**

| | |
|---|---|
| Onsite (Including deC5 and C5 splitter) | $1,060,000 |
| Offsite Tanks and Lines | 200,000 |
| Pro-rata Utilities | 140,000 |
| | $1,400,000 |

| Total Costs | B/CD | ¢/Gal. | $/Bbl. | $/CD |
|---|---|---|---|---|
| Gasoline | 54 | 11.60 | 4.872 | 263 |
| $nC_4$ | (44) | 5.0 | 2.10 | (92) |
| Fuel Gas | (7) | 15¢/MMBtu. | .945 | (7) |
| Loss | (3) | ..... | ..... | .... |
| Total Product Cost | 0 | ..... | ..... | 164 |
| Total Operating Costs (incl. TEL) | .... | ..... | ..... | 1,176 |
| | | | | 1,340 |
| 40% Gross Return on Investment per Year | | | | 1,534 |
| Total Costs Including Return | | | | 2,874 |

$$\text{Cost of Research Octane Number Improvement} = \frac{\$2{,}874}{9{,}150} \times 100 = 31.4¢/\text{RONB}$$

$$\text{Cost of Road Octane Number Improvement} = \frac{\$2{,}874}{7{,}310} \times 100 = 39.3¢/\text{Road ONB}$$

* Numbers in parentheses are negative.

reforming to produce high octane number product is to extract the aromatics from the reformate and recycle the low octane number raffinate.[16, 17, 18] This recycle operation allows less severe reforming conditions for F-1 of a given final $C_5^+$, resulting in a yield advantage over once-through reforming. However, the additional investment and operating costs for this type of process make it more expensive than once-through reforming at low octane numbers. The actual octane level at which recycling becomes attractive varies depending on the type of feed and the average reforming reactor pressure. With the type of feed available in our base refinery, the break-even points for recycle reforming were as follows:

**Octane Level at Which Recycle Reforming Is Competitive with Once-Through Reforming**

| Pressure | F-1 ON (Clear) |
|---|---|
| 500 | 95 |
| 350 | 98 |
| 200 | 100+ |

The octane level at which recycle reforming is competitive decreases as the paraffin content of the feed increases so that in some situations this process would be competitive at lower octane levels than shown above. When reforming naphtha from West Texas Crude, recycle reforming was not competitive at any of the levels investigated in this study.

Another possible reforming operation is to charge $C_5$-200 F naphtha in admixture with thermal naphtha. The material balance of such an operation is predicted in Table 10. At mild severities, this type of operation produces reasonably low cost octane numbers, but as the severity increases, the cost rises rapidly. For example, at 76 F-1 clear (94.6 @ 3 cc), the cost is approximately 15 cents per ON-barrel. When increasing the severity to 83.5 F-1 clear (97.3 @ 3 cc), the cost increases to approximately 30 cents per ON-barrel. This operation will be feasible only when motor gasoline market prices are increased.

**3. Alkylation**—Propylene and butylenes produced by catalytic and thermal cracking are polymerized for motor gasoline in the base refinery. We have evaluated the replacement of phosphoric acid polymerization of light olefins with alkylation as one means of improving motor gasoline octane number. The material balances for polymerization and alkylation operations are presented in Table 11. On a Research octane basis the cost of incremental octanes produced by this method is considerably higher than octanes produced in other ways, as shown in Figure 7. However, since we have assumed that gasoline depreciation must not exceed two units, Road octane number must also be considered. On a Road octane basis alkylation becomes an economical octane producer, as shown in Figure 8.

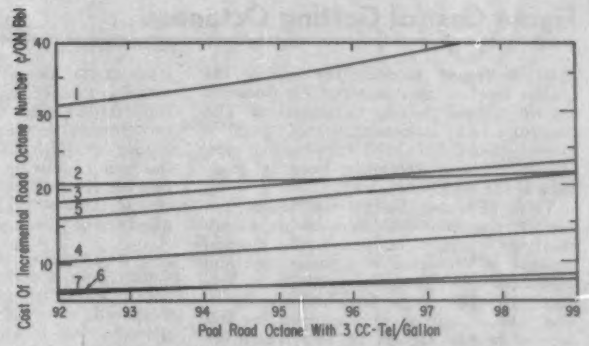


FIGURE 8—On a road octane basis alkylation becomes an economical means of producing a motor fuel. The improvement in octane by pentane isomerization is the most costly. The parameters in this figure are the same as in Figure 7.

The economics of alkylating only butylenes and of alkylating total olefins from polymerization were investigated. The investment and operating cost advantages of the large plant favor the simultaneous addition of propylene and butylene alkylation capacity. A sulfuric acid plant was chosen for the Gulf Coast refinery because this catalyst is readily available. It was assumed that the plant would be designed to produce a premium quality alkylate since the added investment is justified by lower operating costs and increased yield of light alkylate.[21, 22]

The selection of recycle pentane isomerization over pentylene alkylation for 1963 octane number improvement provided the required Research octane number increase at minimum investment. In many refinery situations Road octane requirements for regular gasoline might lead to the selection of pentylene alkylation at this point.

**4. Isomerization.** After depentanizing the light virgin naphtha and reforming the hexane and heavier fraction in admixture with the thermal naphtha, the worst stock in the gasoline pool is the mixed pentanes. Several processes have

**TABLE 9—Reforming Yields at 94 Research Octane Number (Clear)**

| Products | 500 psig | | 350 psig | |
|---|---|---|---|---|
| | BPCD | Vol. % | BPCD | Vol. % |
| Fuel Gas (FOE) | 754 | 10.1 | 701 | 9.3 |
| Propane | 152 | 2.0 | 103 | 1.4 |
| Isobutane | 136 | 1.8 | 112 | 1.5 |
| Normal Butane | 220 | 2.9 | 178 | 2.4 |
| Pentanes and Heavier Reformate | 6,293 | 83.9 | 6,435 | 85.8 |
| Loss | (55) | (0.7) | (29) | (0.4) |
| Charge (200—375F. Virgin Naphtha) | 7,500 | 100.0 | 7,500 | 100.0 |

**TABLE 10—Reforming of Light Virgin and Thermal Naphtha Operation at 76 RON Cl $C_5^+$ Reformate**

| Products | BPCD | Vol. % | Charge | BPCD | Vol. % |
|---|---|---|---|---|---|
| Fuel Gas (FOE) | 269 | 6.7 | Thermal Naphtha | 811 | 20.2 |
| Isobutane | 64 | 1.6 | $C_5$-220 Virgin Naphtha | 3,200 | 79.8 |
| Normal Butane | 92 | 2.3 | | | |
| Pentane and Heavier | 3,610 | 90.0 | | ..... | ..... |
| Loss | (24) | (2.6) | | ..... | ..... |
| Total | 4,011 | 100.0 | | 4,011 | 100.0 |

**TABLE 11**
**Alkylation of Olefins Vs. Polymerization**

| | Base Polymerization Plant Operations BPCD | Alkylation Plant BPCD |
|---|---|---|
| Isobutane | ..... | 1,990 |
| Propylene | 598 | 598 |
| Butylenes | 1,114 | 1,114 |
| | 1,712 | 3,702 |
| Olefins Converted | 1,541 | 1,712 |
| Yields | | |
| Light Product | 1,140 | 2,818 |
| Heavy Product | 60 | 172 |
| Loss | 341 | 712 |
| | 1,541 | 3,702 |

**TABLE 12**
**Recycle Isomerization of Normal Pentane**

| | Feed BPCD | Vol. % | Product BPCD | Vol. % |
|---|---|---|---|---|
| Isopentane | 500 | 45.5 | 1,035 | 94.1 |
| Normal Pentane | 600 | 54.4 | 55 | 5.0 |
| Fuel Gas (FOE) | ..... | ..... | 7 | 0.6 |
| Loss | ..... | ..... | 3 | 0.3 |
| | 1,100 | 100.0 | 1,100 | 100.0 |

**TABLE 13**
**Catalytic Cracking Yields**

| | Base Operation | | After Desulfurization | |
|---|---|---|---|---|
| | BPCD | Vol. % | BPCD | Vol. % |
| Fuel Gas (Incl. $H_2S$) (FOE) | 641 | 3.5 | 694 | 3.8 |
| Propylene | 826 | 4.5 | 922 | 5.0 |
| Propane | 290 | 1.6 | 362 | 2.0 |
| Butylenes | 1,106 | 6.0 | 1,050 | 5.7 |
| Isobutane | 671 | 3.7 | 1,002 | 5.5 |
| Normal Butane | 178 | 1.0 | 205 | 1.1 |
| $C_5$-430F. Naphtha | 7,450 | 40.6 | 7,916 | 43.2 |
| Heating Oil | 5,247 | 28.6 | 5,569 | 30.3 |
| Heavy Cycle Stock | 3,277 | 17.8 | 2,697 | 14.7 |
| Coke and Loss | (1,336) | (7.3) | (2,067) | (11.3) |
| Total Fresh Feed | 18,350 | 100.0 | 18,350 | 100.0 |
| Naphtha Qualities | | | | |
| RVP, psi | 6.3 | ..... | 5.5 | ..... |
| Research Octane w/3cc TEL | 97.3 | ..... | 98.3 | ..... |
| Motor Octane w/ 3cc TEL | 84.7 | ..... | 86.9 | ..... |

**TABLE 14**
**Splitting Catalytic Naphtha and Reformate**
Blending Octane Numbers With 3 cc TEL/Gallon

| | BPCD | Vol. % | Research | Motor |
|---|---|---|---|---|
| Light Cat. Naphtha | 5,690 | 76.4 | 98.7 | 85.8 |
| Heavy Cat Naphtha | 1,760 | 23.6 | 92.7 | 81.8 |
| Total $C_5$-430 F | 7,450 | 100.0 | 97.3 | 84.7 |
| Light Reformate | 2,842 | 45.0 | 97.0 | 90.1 |
| Heavy Reformate | 3,473 | 55.0 | 102.0 | 96.0 |
| Total Reformate | 6,315 | 100.0 | 99.7 | 93.3 |

been developed recently for raising the octane level of this material by isomerizing the normal pentane to isopentane. The literature on isomerization of paraffin hydrocarbons has been reviewed adequately[23-29] and reference here is made only to the review articles.

Table 12 shows the material balance for one of the new fixed-bed, noble metal-catalyst processes in which the normal pentane is separated and isomerized and the unconverted material recycled to produce a 94-95 percent isopentane product. The cost of octane improvement by this process is the highest of any which we would suggest installing during the period examined. For the particular refining situation considered, isomerization is not necessary until 1963.

**5. Hydrodesulfurization.** A number of recent articles suggest that hydrodesulfurization of virgin and recycle cracking stocks increases the yield and quality of the naphtha produced when they are cracked catalytically. In addition to desulfurization, hydrotreating removes metallic contaminants, nitrogen, Conradson carbon and some aromatics, all of which improve the cracking characteristics of the feed. When comparing raw and hydrogenated feed at constant carbon production, the desulfurized feed produces considerably more gasoline and heating oil at the expense of heavy cycle stock. In addition, the gasoline has leaded Research and Motor octane numbers 1 to 5 units higher than gasoline produced from undesulfurized feed. Since this a relatively new process with only one commercial unit in operation, we have included a fairly extensive bibliography.[30-46]

The economics of gas oil hydrodesulfurization were calculated to determine if a unit of this type would be justified. The catalytic cracking yields are shown in Table 13. The yields were calculated on the basis of holding coke production constant at the catalytic cracking unit by increasing conversion after adding the desulfurization unit. On this basis and with no increase in realization price for the higher quality gasoline and heating oil, the unit cannot be justified until it is impossible to produce gasoline of the proper octane. This will occur in 1964-8 if octane numbers of gasoline continue to increase.

**6. Segregation of Components.** Segregation does not produce octane numbers but it allows proper distribution of those produced in conversion units. It may be possible, for example, to manufacture enough octanes to meet pool octane requirements but to be unable to separate the high octane streams to produce a premium gasoline some 7 to 8 octane numbers higher than regular gasoline. In some cases it is cheaper to provide segregation facilities than it is to increase the severity of operations on the octane producing units.

Probably the simplest method of separation is by distillation of the catalytic naphtha and reformate. The front end of the catalytic naphtha has a higher octane number than the average naphtha while the back end of the reformate has a considerably higher octane number than the front end. This distribution of quality with boiling range is shown in Table 14. Thus, if premium gasoline production is limited by component availability, it may be possible to produce the high octane material by fractionation of the catalytic naphtha and reformate to include the front end of the catalytic naphtha and the back end of the reformate in the premium pool.

Examination of the motor gasoline pool for 1960 indicates that there will be sufficient pool octane available but premium gasoline production will be limited by high octane component availability. The most economical way of solving this problem is to install two distillation towers for fractionation of the catalytic naphtha and reformate as discussed above. Component segregation was continued in 1961-1963 to provide high octane components for the premium gasoline.

Another method of segregating high octane components is to extract the aromatics from catalytic reformate. This method will provide higher octane blending components than distillation but it is considerably more expensive. Since the components provided by distillation had a high enough octane level to produce premium gasolines, extraction was not necessary.

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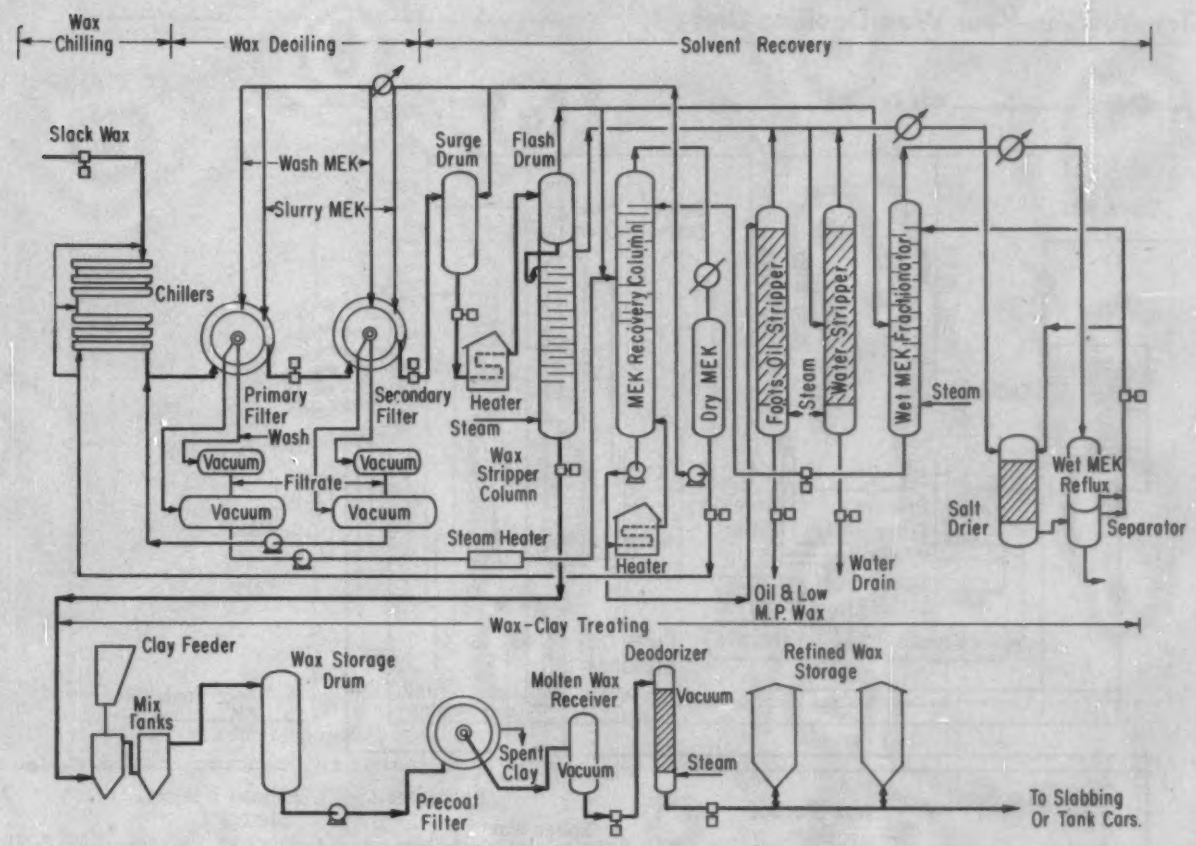


**FIGURE 1—The original process design included a group of towers for removing water from the MEK solvent.**

# Try MIBK in Your Wax Deoiling Unit

**Here is the story of one company which did, and liked the results. Compare the points they considered with your own operation.**

**J. G. Warnecke and P. S. Backlund**
Union Oil Company of California, Rodeo, Calif.

SIGNIFICANT advantages can be gained when the solvent for a wax deoiling process is changed from dry MEK (methylethyl ketone) to water saturated MIBK (methyl isobutyl ketone). Union Oil Company of California made this switch about three years ago at its Oleum refinery near San Francisco. They realized economies in solvent consumption, utilities usage and maintenance expense. Additional benefits were achieved because the change reduced the complexity of the solvent recovery system, increased reliability of the unit,

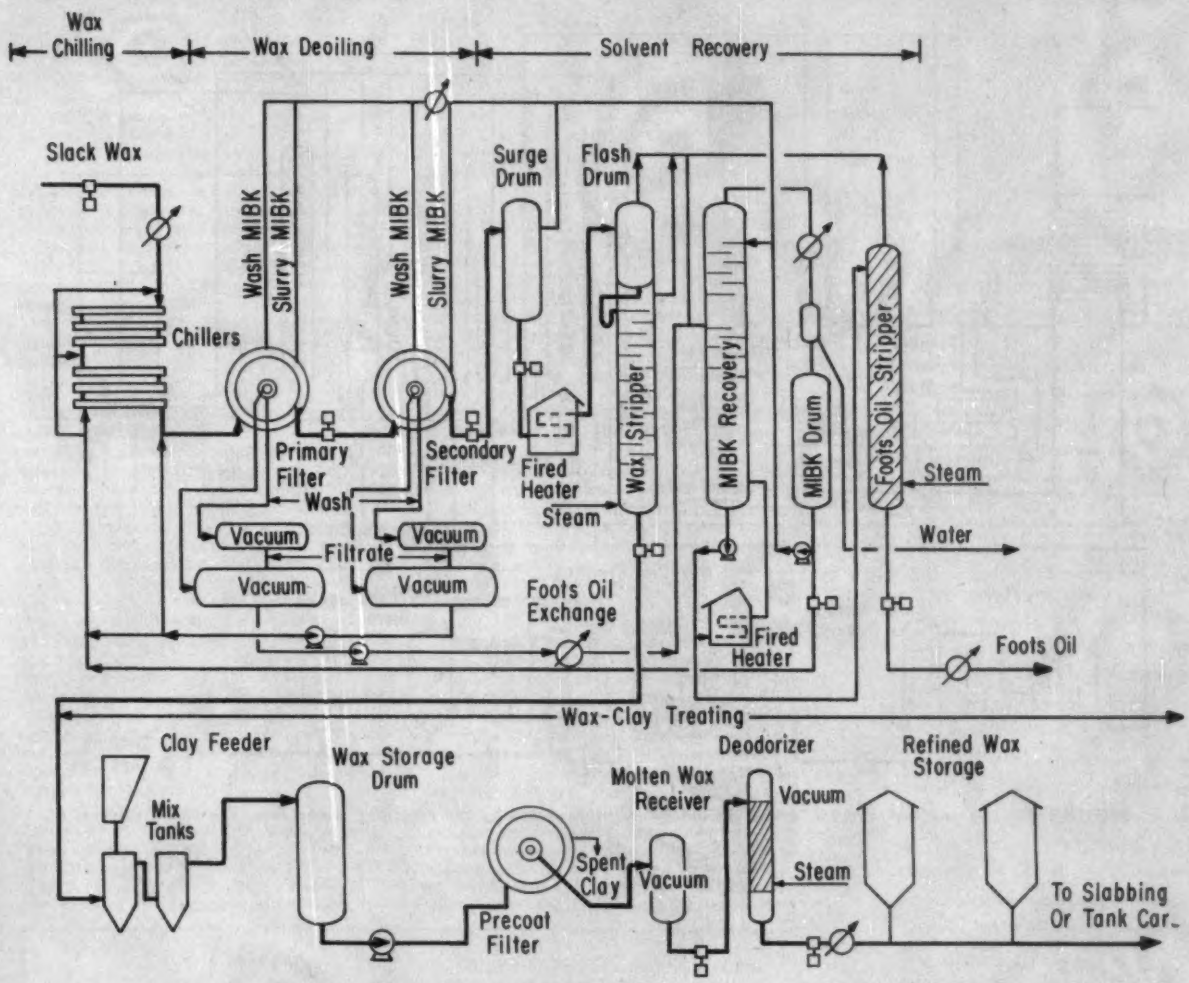


**FIGURE 2—The number of pieces of equipment in the recovery system is greatly reduced by the use of the new solvent.**

and increased over-all throughput. Their present process is shown in Figure 1.

**Original Plant Design.** Equipment employed in the actual deoiling process[1,2,3,4] has remained basically unchanged since originally installed. Some equipment has been deleted, as experience proved it either unnecessary or of insignificant value. Shortly after startup of the unit, the treating clay injection point was changed and steam stripping of the plant products was employed instead of natural gas stripping. This brought about a redesign and allocation of duties of the equipment as shown in Figure 2. This processing scheme was employed without basic change from 1942 to 1954. Chilling capacity was increased in 1945 and the feed stock was changed from distillate slack wax to redistilled raffinate slack wax in 1949. With these changes, plant throughput was increased more than 50 percent over the original design basis. During this same interim period, the number of grades of wax increased from two to six.

**Present Plant Design.** Replacement of the MEK with water-MIBK solvent in September, 1954, has permitted a marked simplification of the solvent recovery system as shown in Figure 1. Components which were removed from service include:

- Water fractionator (azeotrope separator).
- Water stripper.
- Salt drier.
- Brine settler.
- Water fractionator reflux condenser and accumulator.
- Water stripper feed cooler.
- Wax flash drum pressure controller and level controller.
- The following pumps:
  a. Water fractionator bottoms.
  b. Water fractionator reflux.
  c. Brine settler and overflow.

The effective service of all of the above equipment has been replaced by a small water settler trap with an automatic water draw on the line between the solvent recovery column overhead condenser and the overhead accumulator. Operation of this simplified system has been most satisfactory in terms of solvent and utility

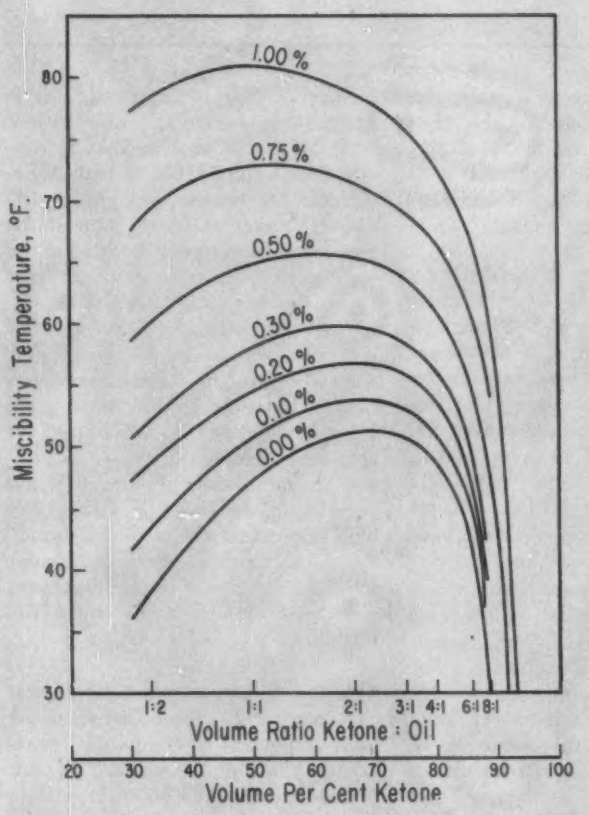


FIGURE 3—Here are the temperatures required to make a high viscosity oil (0 F. pour) miscible with methylethyl ketone. The oil was prepared by dewaxing slack wax at —10 F.

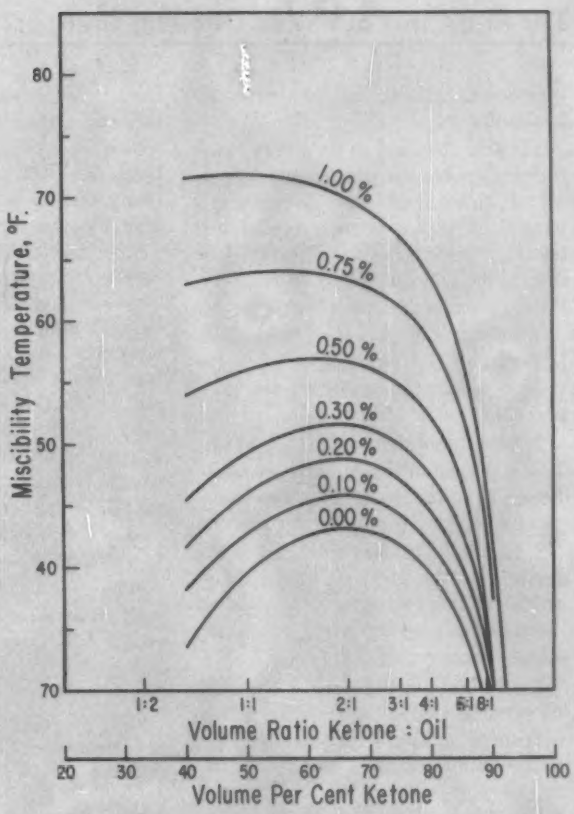


FIGURE 4—Miscibility temperatures are given for the same oil in a mixture of 10 volume percent methylisobutyl ketone and 90 percent methylethyl ketone.

savings and reduction of attention required by the operators.

**Process Advantages of MIBK Solvent.** The decision to change from MEK to water saturated MIBK deoiling solvent was made because of the following predetermined advantages of the latter solvent.

1. Reduced complexity of solvent recovery system.

2. MIBK saturated with water (1.9 vol. percent) had been shown to be as good a deoiling solvent as dry MEK in laboratory tests.

3. Potential reduction in solvent consumption due to reduced volatility of MIBK and lower solvent content of rejection water.

4. Increased solvent miscibility with high molecular weight foots oils.

5. Reduced steam consumption and elimination of salt and drying.

The following anticipated problems were easily solved in the shakedown run with the water saturated MIBK solvent:

1. Lower chilling temperatures (approximately 5 F.) were expected for equivalent yields. This differential caused no excessive load on the chilling system and therefore had no effect on the rate.

2. The higher boiling point of MIBK (240 F.) compared to MEK (175 F.) and the lower relative volatility were expected to result in higher temperatures prevailing than were desirable in the wax-solvent separation system. It was found that these temperatures did not affect the quality of the wax and the heat load was approximately the same as for MEK because of the lower latent heat of MIBK.

3. A filter rate problem was anticipated with the two high molecular weight waxes normally processed. By proper application of incremental dilution principles it was possible to increase the throughput on these up to 50 percent.

**Ideal Deoiling Solvent.** Water saturated MIBK solvent comes very close to meetng the requirements of the "Ideal Solvent" in the Union Oil deoiling process. The properties considered in making the choice are discussed below.

1. Low boiling point for easy recovery; preferably 75 to 95 C.

2. Low solubility in water; less than 5 percent if the water layer is not redistilled.

3. Primary filtering rate must be high; about 10 lb./sq. ft./hr.

4. Water saturated solvent must be miscible with filtrate oil at deoiling temperatures at a ratio of not over 2:1 solvent to oil.

5. Solvent should have a narrow boiling range such as is provided by pure compounds; this avoids control of composition.

6. Solvent must be commercially available.

MEK was found to be a very satisfactory solvent for the removal of low VI oil from slack wax. When raffinate slack waxes became available it became necessary to improve the miscibility of solvent and oil. The following measures were considered:

1. Dilution of the slack wax with low VI oil. This practice reduced the yield of wax at a given filtering temperature.

2. More complete drying of MEK. This too was an undesirable situation due to running too close to the maximum efficiency of the drying system.

3. Increased solvent dilution for the deoiling of the 165 wax grade (Figure 3). This procedure reduced throughput rate by overloading the solvent recovery system.

4. Dilution of solvent with light hydrocarbon or higher boiling ketone (Figure 4). The hydrocarbon dilution reduced the yield too much and the use of mixtures of MIBK and MEK required excessive controls of composition.

5. The benefits of the use of 5 and 6 carbon ketones saturated with water as deoiling solvent were discovered.[5] MIBK, the ketone in this class most readily available, was tried in the full scale plant and found to have the advantages already described. Other ketones of this class which are not so readily available, have not been tried in the full scale plant, but have also been found suitable for the deoiling process.

**Costs.** In addition to reduced solvent consumption the major gains made by conversion to water-MIBK solvent were in the area of simplification of the solvent recovery process and reduction in steam, cooling water, and power consumption. The aggregate effect of these economies was to reduce total 1956 processing cost to 94 percent of the 1953 amount and 1956 maintenance cost to 73 percent of the 1953 amount.

The year 1953 is used for comparison, since it is the last full year in which MEK was used. These figures are based on actual dollars for the given years and are not corrected for wage and other cost increases. During this same period, production of finished waxes increased 60 percent.

**Filter Rate.** For the conventional dewaxing processes where all of the solvent is dissolved in the waxy oil before chilling, the filter rate has been shown to decrease with increasing molecular weight of the ketone solvent. In the Union Oil process where controlled addition of solvent during chilling is practiced, this is not uniformly true. The 130/134 and 143/150 grades of wax filter as rapidly with water-MIBK as with MEK solvent. The heavier wax grades, 165 and HV filter relatively slow if the first solvent increment is added to the wax mix at molten wax temperatures. For practical filter rate in deoiling wax grades above 150 F. melting point with water-MIBK solvent, careful control of chilling conditions has been found desirable. Since much less recovered MIBK is required for complete deoiling, there is an improvement in throughput rate of 50 percent in deoiling the 165 grade. This improvement is obtained despite the fact that these high molecular weight waxes yield lower filter rates with water-MIBK than with MEK solvent.

**Process Control.** Wax crystallization control has been found to be more important in commercial practice than in the pilot plant. This control, as expected, is more critical in the case of the two heaviest grades of wax—the 165 and the HV fractions from the vacuum distillation of Duo-Sol type slack wax. These fractions without crystallization control will form a tight wax cake on the filters which occludes oil and is very resistant to both filtration and washing. This effect has been minimized by careful control of chilling temperatures and dilutions.

Thus use of water saturated MIBK as a wax deoiling solvent has been proved in three years of commercial experience to be completely practical and to have significant advantage over dry MEK. Information on a particular phase of this operation may be obtained from Union Oil Company of California, Commercial Development Division, Brea Research Center, Brea, Calif.


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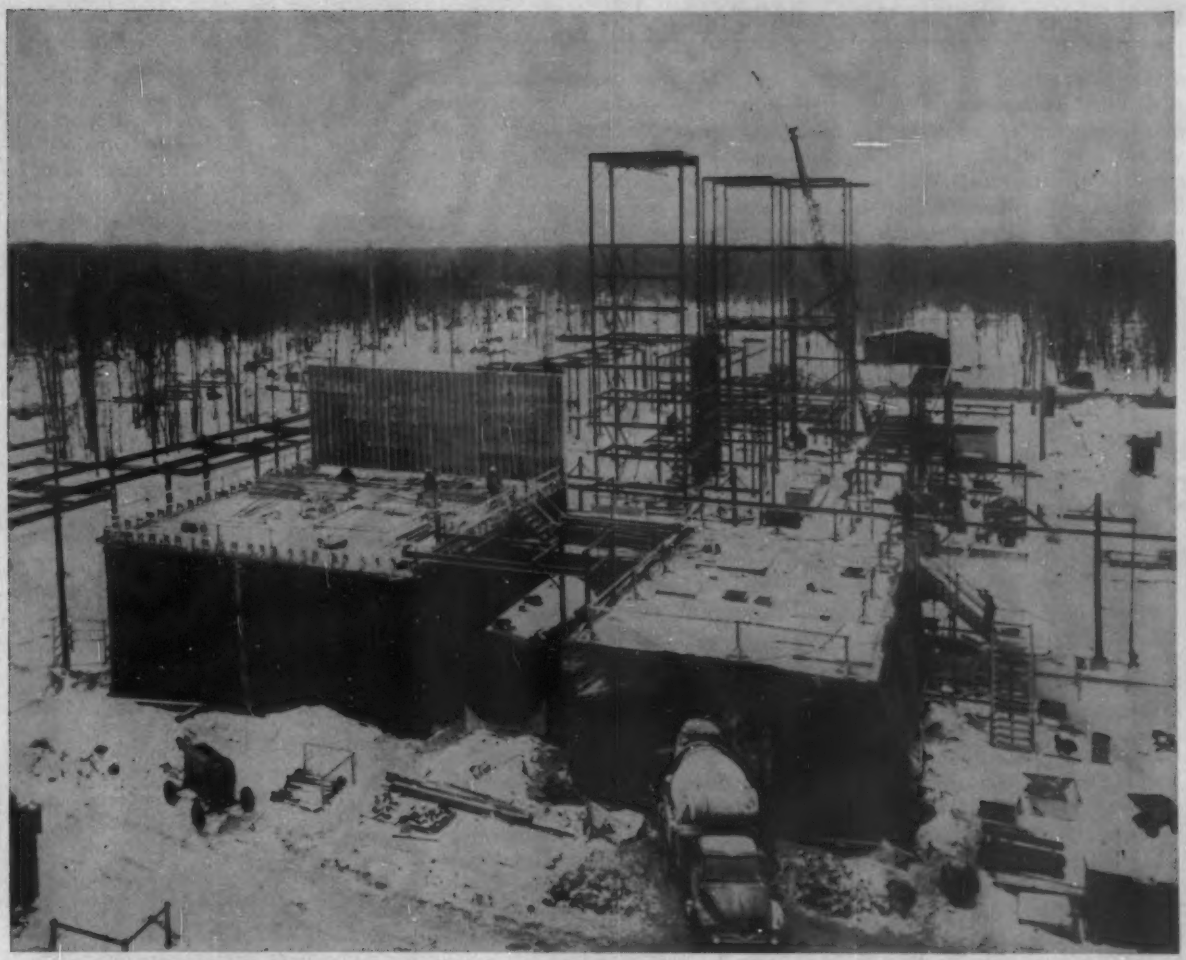

Snow halted this construction project. Note such idle equipment as the crane, concrete truck and the motor generator.

# Watch the Weather When Building

**A close check on even the moderate weather can sometimes mean big savings on an outdoor construction job.**

**W. R. Chalker and A. E. Boyer**
E. I. du Pont de Nemours & Company (Inc.)
Wilmington, Del.

MANY EXAMPLES of spectacular weather have been in the headlines—blizzards, floods, tornadoes and hurricanes. The consequences of these weather extremes are well known—damage to property, economic dislocation for whole communities and even loss of life. On the other hand, the more "moderate" forms of weather —the all-day rain, the gusty winds of the type associated with March, or the overnight freeze occur frequently and are looked upon by most as mere inconveniences.

To the construction industry these so-called "moderate" forms of weather can be very nearly as costly as the spectacular forms. Once built, most structures will withstand a hurricane or the equivalent. But during the actual construction period, the job is

often vulnerable to "moderate" forms of weather. To the contractor, a heavy rain can mean days of delay if it fills an excavation. Rain can ruin a concrete pour and halt or damage insulation work. Moderate winds can make roofing operations impossible and make steel erection or scaffolding jobs hazardous. Freezing temperatures may mean broken pipes, a ruined concrete pour and loss of unprotected equipment or instruments. To the contractor, the weather is a concern from the day of the initial planning.

## HERE'S HOW WEATHER FORECASTING HELPS

**Case A** The 8 a.m. forecast stated that the occasional light rain falling at the time would continue intermittently until about 4 to 6 p.m. with a total accumulation of 0.1 inch. With this information, supervision maintained their schedules for work in subgrade areas and no concrete pours were cancelled. Pours requiring a grade "A" finish, which would reach the "drying" and "setting up" stages before 4 p.m. were postponed a few hours to assure that the rain would be over when these stages were reached. Electrical linemen were rescheduled to inside work. Likewise, installation of steam lines was postponed because of the adverse effect of rain on the magnesium insulation.

**Case B** The morning forecast stated the present moderate rain was associated with a fast-moving cold front and was expected to end within about three hours. Accumulation was estimated at ½ to ¾ inch. Strong gusty winds, 35 to 40 miles an hour, were expected during the afternoon. Supervision decided to hold labor on the job. Since concrete pours can be carried out in a rather heavy rain, provided the rain diminishes to a drizzle or stops when the "drying" and "finishing" steps are reached, the scheduled pours were started. Work in some subgrade areas was cancelled because of mud and problems with heavy equipment, and in these cases, labor was shifted to above-grade areas. Electrical and insulation workers were held on the job; while their work was delayed a few hours, a whole day was not lost. Because of the strong gusty winds, roofing and scaffolding operations were postponed to avoid hazards to personnel.

**Case C** This forecast called for no rain during the day, but indicated that weather trends favored appreciable rains of up to three-quarters of an inch to move into the area between midnight and 8 a.m. the next morning. At the time, work on a large pipe line being layed across the site had reached a depression or hollow. The engineer in charge, on receipt of the weather advisory, called in extra crews and rushed the job to get out of the hollow and onto higher elevations. The forecast and timely decisions kept the job from being delayed in the heavy rain that followed. No pumping or cribbing costs were encountered and the job proceeded on schedule.

**Case D** At 8 a.m. when this forecast was issued, the temperature was below freezing. The advisory stated that temperature would rise to a high of about 38 F. and remain above freezing (32 F.) for only three to four hours before again dipping to below freezing and reaching an overnight low of about 22 F. On the basis of this information, concrete pours were postponed because the estimated number of hours of above freezing temperatures was insufficient for the "setting up" and "finishing" stages.

Construction experience now shows the use of a specialized weather service can give substantial savings. Because weather forecasts are, in essence, statements of probability and not certainty, an objective method is proposed for making decisions in which weather probabilities are clearly recognized and considered along with the economic aspects of the job. Its application, however, requires considerable prior evaluation on the cost for protection and losses which might be sustained by the occurrence of critical weather. In practice, such information will be accumulated slowly.

Our proposal for an objective method for making decisions based on probability weather forecasts must be tested by additional experience before its merit can be evaluated. However, the difficulty in estimating the monetary value of a specialized weather service is not halting the increasing use of this service by the construction industry.

**Experience Report.** The Du Pont Company has had meteorologists on its staff since 1943 to advise on new plant locations, to make applied climatological studies and to deal with air pollution problems. In recent years weather forecasting has been provided on some construction jobs.

The most notable success in using weather predictions was achieved in the building of the Atomic Energy Commission's Savannah River plant. The relatively large economic value of using weather predictions on this AEC job was undoubtedly due, in part, to a series of circumstances not often reproduced. First, the job was big. There were 35,000 to 40,000 workers, the majority of whom were engaged in out-of-doors activities; vast amounts of materials and equipment were involved; and geographically all activities were concentrated in a relatively small area where communications with all personnel was no great problem.

It was soon evident that additional refinements or interpretations had to be placed on the general type forecast if maximum benefits were to be derived. For example, a general forecast given out on the radio might call for "rain tomorrow." In itself, this is not sufficiently explicit to be of much use to construction personnel. With some further analysis, the same mete-

orologist could expand this forecast to read as follows: "Rain will start about 6 or 8 a.m. tomorrow. It will be light, intermittent until about noon, becoming moderately heavy in the afternoon and end about 3 to 4 p.m. Total accumulation in the forenoon is estimated at a tenth of an inch and five tenths inch in the afternoon." The second forecast, including estimates of time and severity, gives the contractor some basis for planning and scheduling his work for the next day. It is useful. Other refinements over the general forecast include: predictions of the duration, in hours, of a temperature above or below freezing, not just the minimum or maximum temperature; forecasts of the relative humidity; and ground level temperatures at the specific locations where foundations are poured, not just the free air temperature which can be many degrees different.

A weather office with the usual teletypes and meteorological instruments was set up at the Savannah River construction site. On a routine basis, a 36-hour forecast was ready for construction supervision at 8 a.m. with a follow-up at 2 p.m. Specials or modifications were issued at any other time of the day or night that conditions warranted. The examples in the accompanying box illustrate the type of weather information provided and its use in construction planning.

**Problems in Evaluation of Savings.** The examples illustrate in a qualitative manner how weather predictions have been used to avert or minimize losses. In practice the actual savings are very difficult to evaluate. Du Pont practice has been to leave the estimate of amount saved entirely to the judgment of the person to whom the forecast is furnished. Impressive savings have been reported on some jobs, but others have shown negative results. This difference may well hinge on the degree to which the construction engineer accepts the idea of using weather forecasts and his willingness to spend the necessary time in evaluation. But beyond this is the need for an objective and reasonable datum. In other words, the problem is to define what would have happened if the industrial meteorologist had not furnished a forecast. No entirely satisfactory solution to this problem has been found.

Past evaluations have not included the losses resulting from incorrect forecasts. If the weather occurs as forecast nine out of ten times, the meteorologist may feel he is providing a valuable service. However, there are jobs on which the loss incurred by one incorrect forecast may be greater than the savings made by nine correct forecasts. A realistic appraisal must consider the losses along with the savings. Also, the evaluation must cover a period of time. The net savings are obviously a function of the size, type and duration of the construction job. It may be difficult to justify meteorological service for a small job.

An essential factor for judging savings is an estimate of the potential damage for various weather conditions. For example, a forecast of freezing temperatures may result in the draining or steam chasing of a pipe line. This can be costly. The question is, would the line have frozen if no action had been taken? Obviously, it would not if the minimum temperature dropped to just 32F and it most likely would have if the temperature dropped to 0F. Somewhere between there is a critical temperature. This critical temperature will depend on such factors as size of the pipe, rate and type of material flowing through the pipe, wall thickness, material of construction, and location of the pipe relative to the ground. This point is emphasized because without proper definition of the critical weather, needless expense can arise from protecting more frequently than is required. It is necessary, therefore, to determine in advance what weather event is required to produce a loss.

This definition of critical weather together with a weather forecast will enable the construction engineer to make the optimum decision as outlined by the following technique.

**Objective Decisions.** Most operational-weather problems pose a choice between a conservative course of action at a low cost penalty and a risk decision which involves a somewhat improbable weather loss of greater magnitude. For example, it would be conservative to protect all newly poured concrete floors from freezing. The cost of this conservative decision might be $100 per night. The alternative of leaving the floor unprotected involves a certain risk which might involve the loss of, say $1000 if the floor froze. The ratio of the cost of a conservative decision to the possible loss from a risk decision will be referred to as the cost-loss ratio, in this case 10 percent. It will be illustrated later that in any operational-weather problem the risk decision *should not be followed unless the chance of a loss is less than the cost-loss ratio.* In the foregoing case, the probability of freezing temperatures should be less than 10 percent before protection is omitted. In other words, it is best to have the odds in your favor before taking any chances.

The above reasoning implies that the "chances of a loss" are known or can be determined. It has been stated previously that it is necessary to determine the critical weather event: that event which is required to produce a loss. Once the critical weather event has been established, the chances of a loss are the chances of critical weather.

Forecasts in terms of the chances of critical weather are also desirable

**To Figure Savings | CONSIDER THESE FACTORS**

- **Definition of Critical Weather**
- **Cost of Conservative Decision**
- **Possiblle Loss from a Decision**
- **Chance of Critical Weather**

from the forecaster's point of view. It makes possible the addition of weather information not normally included in the forecast. For example, a forecast of "scattered showers" might refer to a summer afternoon when 5 to 10 percent of the area will receive rain. On the other hand, it might also be used to describe the passage of a cold front in which 60 to 70 percent of the area would receive rain. A general forecast of scattered showers can have a very different meaning in the first case as compared to the second. If rain were the critical weather event for a particular job, the forecast in each case in terms of the chances of critical weather would be:

1. Scattered showers—the chances of rain at the site are 5 to 10 percent.
2. Scattered showers—the chances of rain at the site are 60 to 70 percent.

These concepts are not entirely new. The recent efforts of others to set forth a method to measure the economic utility of weather forecasts is perhaps best typified by J. C. Thompson and G. W. Brier.[1]

**Example.** For the purposes of illustration, suppose that if a construction supervisor scheduled a particular outdoor job and it rained, he would have to pay idle workers until they could be transferred to indoor work or be sent home. This may cost him $200. In addition, postponement of the job because of rain or in anticipation of rain may delay the project completion date. This delay can result in lost production or other penalties. Suppose that the cost of delay in this case is $1000. The total loss in the event of getting caught in the rain would be $1000 plus $200 or $1200, and the cost-loss ratio would be

$$\frac{1000}{1200} = 83 \text{ percent.}$$

The critical weather in this case is defined as rain. Now, suppose the forecast called for "cloudy with a 20-40 percent chance of rain." With this information what is the optimum decision? Consider the various alternatives:

| Cost of conservative decision to postpone job | No Rain $1000 | Rain $1000 |
|---|---|---|
| Loss from a risk decision to schedule job | 0 | 1200 |
| Chances of happening | 60% | 40% |

The expense of a risk decision would be either 1200 or nothing. The average expense of each of a number of such decisions would approach $480: $1200 × .40 = $480.

The average expense of a conservative decision to postpone the job would be $1000: $1000 × .60 + $1000 × .40 = $1000.

The most economical solution would be to take a chance and plan the job. Note that the use of 20-80 percent chance of critical weather would have resulted in the same decision.

It may seem academic to go to all this trouble to show what common sense would have dictated anyway; however, some cases are not as clear-cut as this. Suppose, for example, that the probability of rain were 60-70 percent. What would be the optimum decision?

| Cost of conservative decision to postpone job | No Rain $1000 | Rain $1000 |
|---|---|---|
| Loss from a risk decision to schedule job | 0 | 1200 |
| Chances of happening | 30% | 70% |

The average expense of the risk decision to schedule the job would be: $1200 × .70 = $840.

The average expense of a conservative decision to postpone the job would be $1000.

The most economical solution would be to schedule the job even though there is better than a 50-50 chance of rain. Since the penalty of getting caught in the rain is only slightly more than that of delaying the project, the supervisor is willing to take a chance on rain in order to complete the job. The occurrence of rain should be highly probable before consideration is given to postponing the job. In this case the probability of rain should be 83 percent or more before the conservative decision of postponing the job becomes economical. Note that 83 percent is also the cost-loss ratio. In other words, the *risk decision should not be followed unless the chances of a loss are less than the cost-loss ratio.* In all the cases cited the chances of critical weather were less than the cost-loss ratio of 83 percent and as a result it was economical to risk scheduling the job in each case. Thus, it can be seen that a forecast of "rain" can be interpreted differently depending upon the "chances of rain" and the cost-loss factors of the particular job.

Some benefits from using weather forecasts do not lend themselves readily to such a cost analysis. Foremost among these is the safety of personnel. For example, the use of a high wind forecast to keep crews off towers and scaffolds and to police the site for loose objects is beyond simple monetary considerations.


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## About the Authors

Chalker

Boyer


**W. R. Chalker** is employed by E. I. du Pont de Nemours & Co. where he is a consultant supervisor located at Wilmington, Delaware. Among his duties for the company are: supervisor of environmental engineering activity in the engineering department. This activity includes specialized weather forecasting, climatological studies, air pollution control, and industrial noise control. He was formerly an Aerologist for the U. S. Navy at air stations and aboard ship on North Atlantic weather patrols. He also worked for the U. S. Weather Bureau, A. H. Green and Associates in weather and sea forecasting for offshore drilling, and Office of Naval Research. Engaged in meteorological activities since 1944, Chalker taught weather forecasting at Massachusetts Institute of Technology, where he received an M.S. degree. He also has A.B. and B.S. degrees from the University of South Carolina, and a Diploma of Engineering from the U. S. Naval Academy.

**A. E. Boyer**, also with E. I. du Pont de Nemours & Co., is a service engineer at Wilmington. His duties include industrial meteorology, problems in air pollution, weather forecasting, and climatology. Boyer served one year with the Military Air Transport Service as a flight forecaster, two years with the Strategic Air Command as a long range forecaster, and has been with Du Pont for three years as an industrial meteorologist. He has a B.S. degree in chemical engineering from Michigan College of Mining and Technologyy, and a B.S. degree in meteorology from Pennsylvania State University.

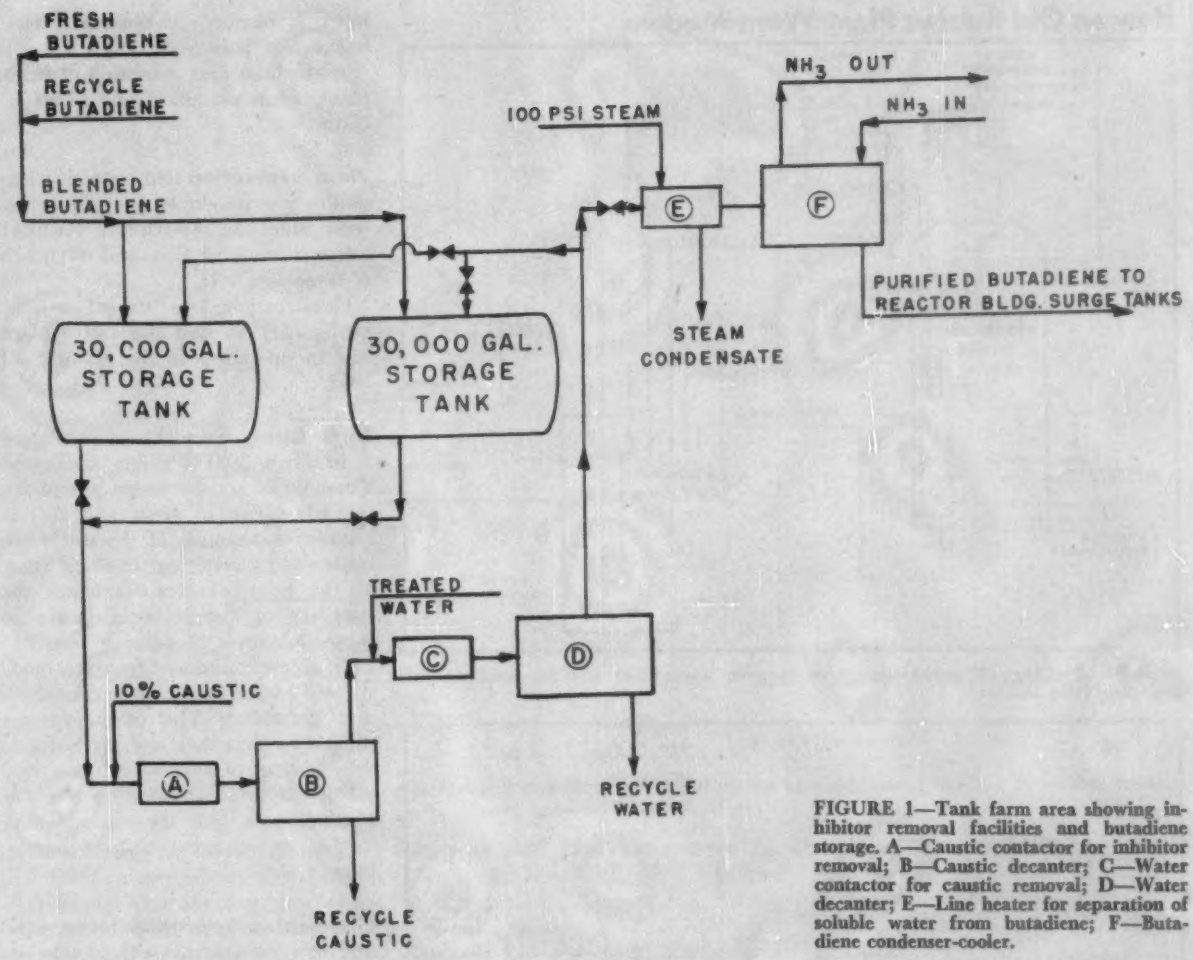



FIGURE 1—Tank farm area showing inhibitor removal facilities and butadiene storage. A—Caustic contactor for inhibitor removal; B—Caustic decanter; C—Water contactor for caustic removal; D—Water decanter; E—Line heater for separation of soluble water from butadiene; F—Butadiene condenser-cooler.

# How an Old Rubber Plant Went Modern

**Here's how American Synthetic added capacity to become one of the most versatile synthetic rubber producers.**

**Ray Marsh**
Walter Kidde Engineers Southwest, Houston

AMERICAN SYNTHETIC Rubber Corporation at Louisville, Ky., now has one of the most modern facilities to go into operation since the advent of private ownership in this field. The new plant differs from the original plant in process and equipment design.

Starting with two main chemical ingredients, butadiene and styrene, versatility built into the plant permits running many different types of synthetic rubber without any plant changes. The plant is designed to produce 25,000 long tons per year of a single type of SBR rubber on a batch basis.

There are six basic areas:

**1.** Tank farm and purification area where fresh and recycle butadiene are blended and inhibitor removed.

**2.** Chemical preparation area where various intermediate solutions are prepared for reactor recipes.

**3.** Reactor area for polymerization of butadiene and styrene.

**4.** Recovery area where unreacted butadiene and styrene are stripped from the latex.

**5.** Process and finishing area where

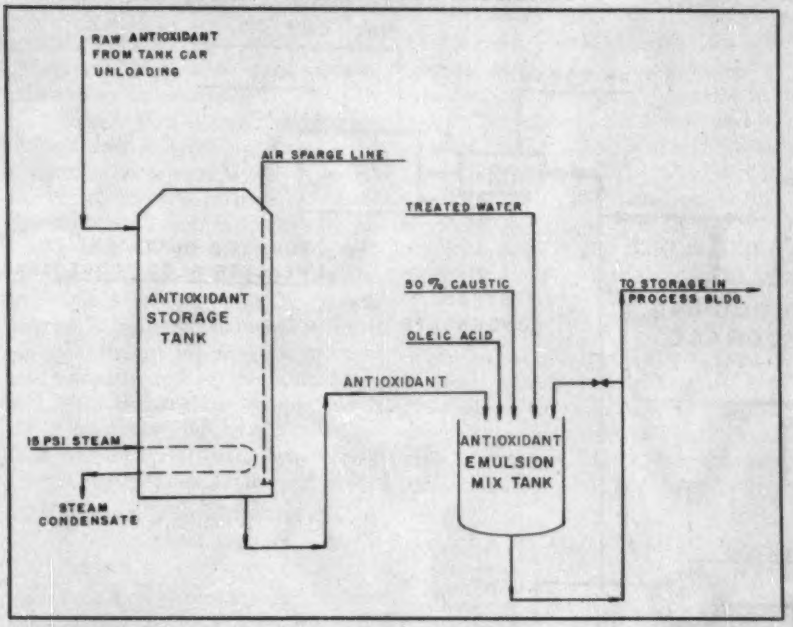



**FIGURE 2—Chemical preparation area showing antioxidant storage, emulsification and dispensing system.**

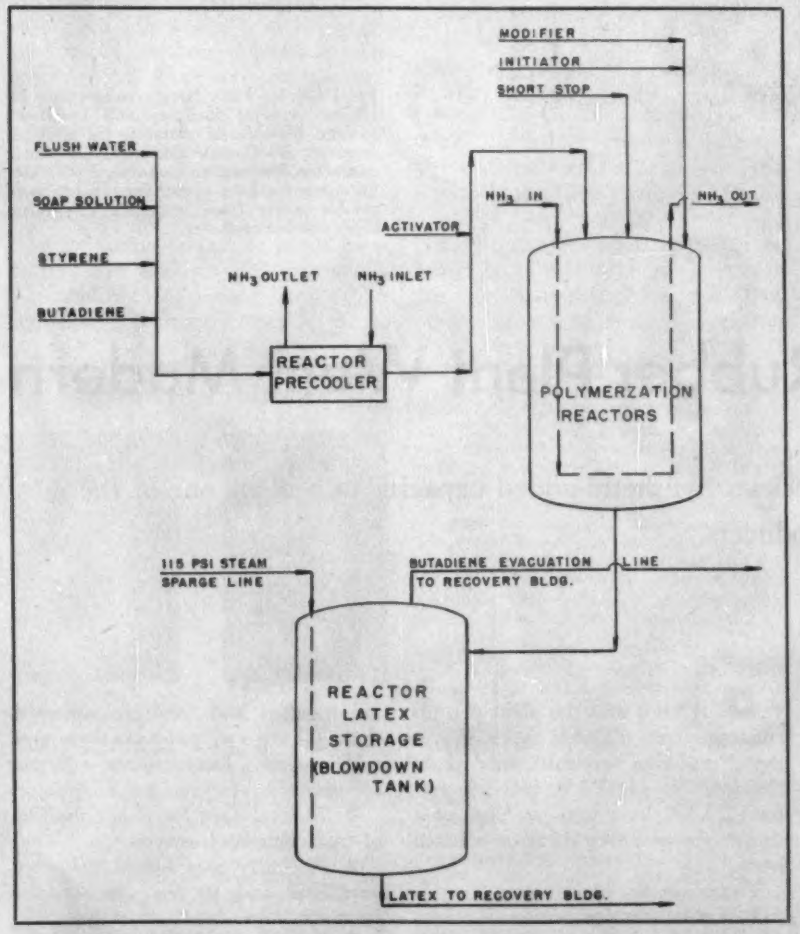



**FIGURE 3—Reactors and latex blowdown storage.**

latex is blended, coagulated, dried, baled, and packaged.

**6.** Utilities area consisting of steam plant, ammonia plant and other facilities.

**Plant evaluation** and economic feasibility was developed in conjunction with American Synthetic Rubber Corporation and Cox and Weinrich of Washington, D. C.

Construction was started in the spring of 1956 and the entire plant was in operation in the summer of 1957.

**Tank farm area** shown in Figure 1 has two 30,000 gallon horizontal blend tanks and necessary pumps for the blending of fresh and recycle butadiene. Volumes of the stocks are measured by metering. In-situ mixing of the components eliminates the necessity of pump recirculation to insure adequate blending.

Inhibitor is removed from the butadiene by water and caustic contactors and decanting. The contactors are unique in that they operate horizontally instead of vertically. The entire set of baffles is mounted on rods for removal as a unit for easy cleaning similar to removing a tube bundle from a shell.

**Chemical preparation area** utilized existing facilities except that an additional antioxidant bulk storage, emulsification and dispensing system was added. (Figure 2)

**The reactor area** as shown in Figure 3 contains automatic metering and reactor charging equipment as well as unstripped latex storage.

The metering section is entirely automatic. The charging unit pumps, meters, and other equipment carry on the complete charging cycle including the necessary flushing of lines.

The reactor section contains twelve 3,750 gallon reactors with internal ammonia refrigerant coils which control the reaction temperature at 41 F.

Four 7,500-gallon blow down tanks receive the unstripped latex from the reactors where it is heated before transfer to the recovery area for stripping of the unreacted butadiene and styrene.

**Recovery area** as shown in Figure 4 recovers unreacted butadiene and styrene from the latex. The new strip-

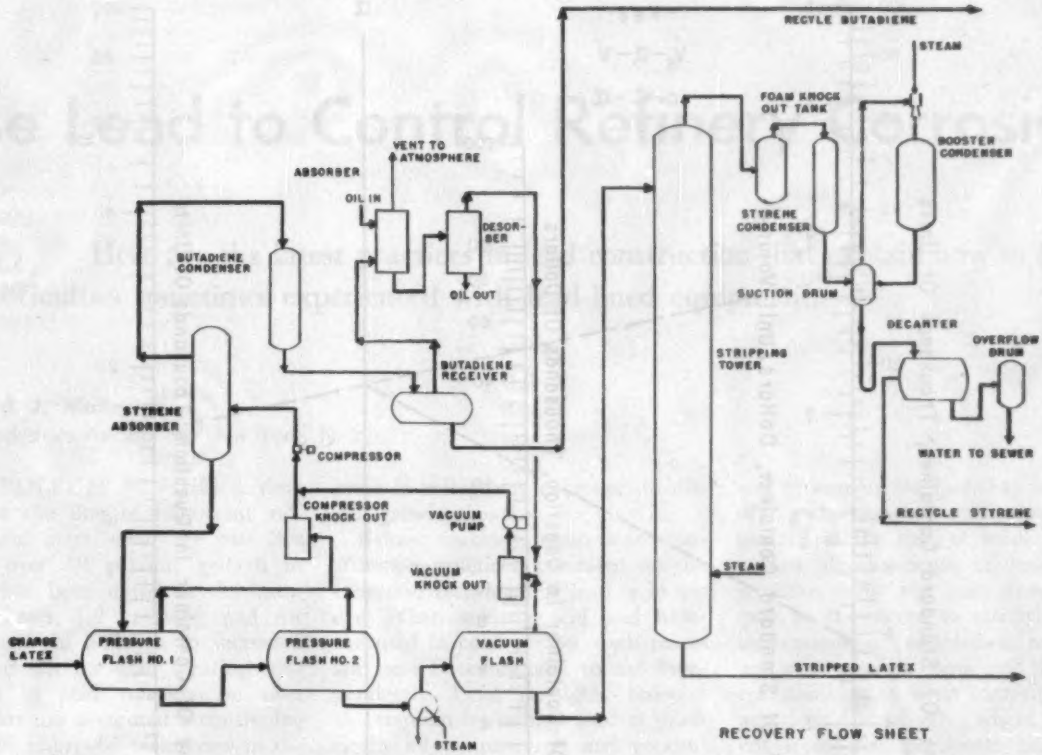



**FIGURE 4—The largest stripping column ever installed as well as the vertical styrene condensers are unique for the rubber industry.**

ping column, the largest of its kind, has a design throughout of more than 100 gpm. The stainless steel trays were polished to minimize the build up of rubber on the surfaces.

This fine tray finish saves down-time and cleaning expense. Earlier stripping columns required tray removal and solvent cleaning or in place scraping to remove accumulated rubber. With the new trays, rubber is easily removed and turnaround reduced from 1-5 days to 16 hours.

Styrene is flashed from the latex in the stripping column and fed to four vertical single pass condensers. This type of condenser is also unique in that rubber does not build up in the head and around tubes and the straight through flow allows for easy rodding of the tubes for cleaning. The styrene-water mixture is decanted and returned to storage.

Butadiene is flashed in a series of vacuum and pressure flash tanks, compressed, condensed and returned to recycle storage tanks in the tank farm. A vent gas system recovers butadiene which might otherwise be lost to the atmosphere during the intermittent release of non-condensable impurities.

**Process and finishing area** has three 40,000-gallon glazed tile-lined concrete tanks. These tanks contain two side-entering agitators. Here the latex is blended with antioxidants. The latex is coagulated by the use of suitable creaming and coagulating agents. The crumb (or coagulated latex) is dewatered on conventional shaker screens and vacuum filters.

The partially dried blankets from the filters are broken up in hammer mills and blown into the first pass of the circulating hot air drier. The three pass driers discharge into elevators. An innovation to the rubber industry, these elevators are natural frequency spiral type and require very little power. Saving in maintenance cost should be realized because of few moving parts. Bucket type elevators used in the past have always presented problems in maintenance and plug-ups.

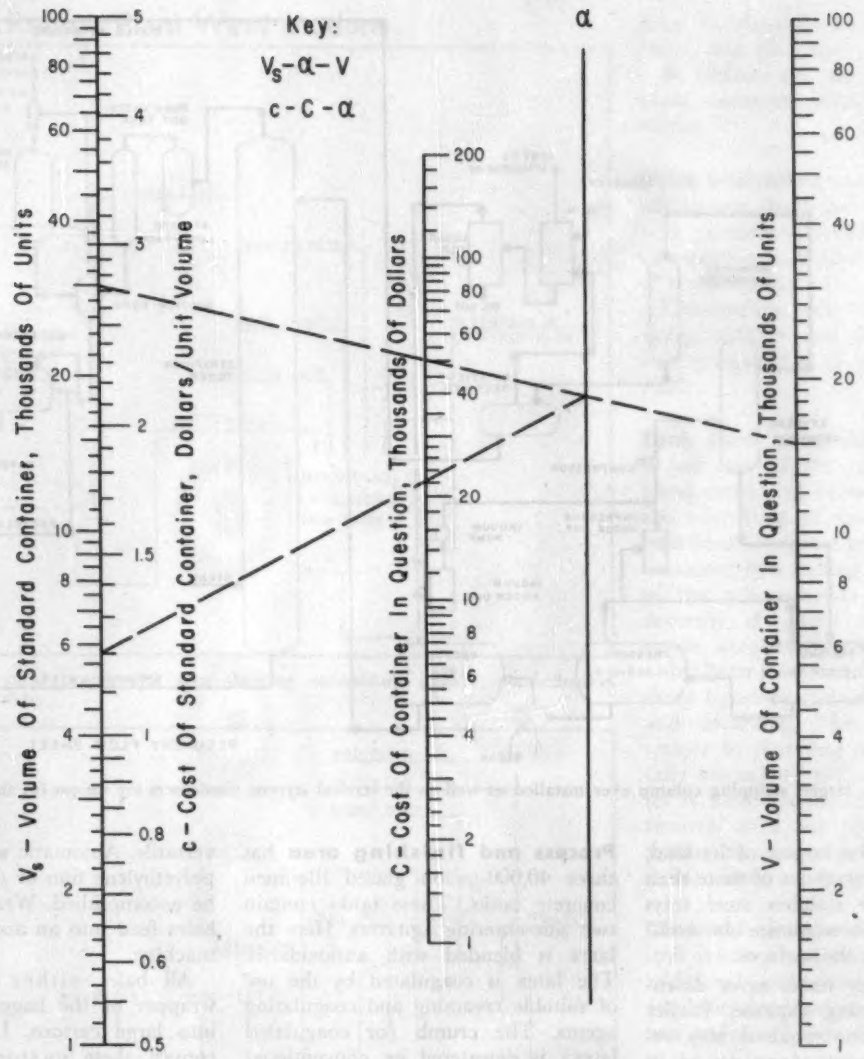
**Automatic scales** feed by gravity into the balers, which compress the dried crumb into 75-pound bales. Each bale passes through a metal detector which sounds an alarm and stops the conveyor should any metal be detected.

The packaging system is extremely versatile. Automatic wrapping bale in polyethylene film or dusting only can be accomplished. Wrapped or dusted bales feed into an automatic bagging machine.

All bales, either from the film wrapper or the baggers, are packed into large cartons. Lift trucks then convey these cartons to platform scales and storage for rail or truck shipment.

**About the Author**

**Ray Marsh** graduated from the University of Maine with a B.S. degree in engineering. He has had 26 years experience on major projects including the Corps of Engineers, Navy C.E.C. and Stone and Webster Engineering Corp. He joined Walter Kidde Engineers Southwest, Houston, in early 1951, where he has been project engineer, chief project engineer and is at present a contract engineer for that organization.


Key:
$V_s$-α-V
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α
$V_s$ - Volume Of Standard Container, Thousands Of Units
c - Cost Of Standard Container, Dollars/Unit Volume
C - Cost Of Container In Question, Thousands Of Dollars
V - Volume Of Container In Question, Thousands Of Units

# Find Tank Costs by Nomogram

**D. S. Davis**
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THE ACCOMPANYING nomogram enables one to estimate the cost of a steel container of given volume when one knows the cost and volume of another or standard container. The chart, constructed by means of well-known methods,[1] is based on the equation[2]

$$C = c\,V_s^{0.3}\,V^{0.7}$$

where C = cost of container in question, dollars

c = cost of standard container, dollars per unit volume

$V_s$ = volume of standard container

V = volume of container in question

and $V_s$ and V are expressed in the same units: gallons, cubic feet, barrels.

In accord with Dickson's suggestions,[2] the chart can be used for drums of the same diameter and internal pressure, and for spheres of the same internal pressure.

**Example**—If a 30,000-barrel tank costs $36,000, what should be the cost of a 15,000-barrel tank? For the standard tank, c = 36,000/30,000 or $1.2 per barrel. Follow the key; connect 30,000 on the $V_s$ scale with 15,000 on the V-scale and note the intersection with the α-axis. Connect this point with 1.2 on the c-scale and read the desired cost of approximately $22,000 on the C-scale.

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[1] Davis, D. S., "Nomography and Empirical Equations," Chapter 6, New York, Reinhold Publishing Corporation, 1955.
[2] Dickson, R. A., Chem. Eng., 54 (8) 122 (1947).

# Use Lead to Control Refinery Corrosion

**Here are the latest practices in lead construction that explain how to avoid the difficulties sometimes experienced with lead-lined equipment.**

**Edward J. Mullarkey**
Lead Industries Association, New York, N. Y.

PETROLEUM REFINERS rank high in the line of important sulfuric acid users. Over the past five years, over 40 percent growth in usage has been noted in the catalytic phases, for cracking and for alkylation. In addition to increased requirements for acid treating, this growth in acid consumption over the years has presented a continuing need for improved techniques in the use of lead chemical construction. In the areas of acid-production, containment of weak acid and acid sludges, and acid-reclamation, largely the consequences of the above-mentioned processes, few contest lead's important role.

Although by far the largest job for lead in oil refining, sulfuric acid handling is not alone in its demands. Perhaps not as large a use but definitely an important one is in the storage of alum solutions used for fire fighting. Lead's major uses do not end here, however, and it is not illogical that it is found in alum digestors and in production and containment of acid-alum solutions used in thermofor catalytic cracking. The latter use, in the reactor stage constitutes one of the severest tests of lead's applicability to date.

It is the purpose of this article to bring up-to-date the latest practices related to lead chemical construction because mechanical troubles are responsible for the greater part of such difficulties as are experienced with lead lined equipment. Knowledge of the corrosives encountered and their behavior with lead are also important. A typical case history commentary also adds to the useful knowledge of lead's employment in mitagating corrosion in this still growing market.

Before touching upon lead construction practices, comment on the corrosion resistance of lead is in order. When sulfuric acid and alum are used in combination, each reactant may be considered to act independently. Lead is highly resistant to corrosion by sulfuric acid at practically all temperatures and concentrations, although somewhat more corroded by very dilute or very concentrated acids.

Frequently mis-stated in the literature is the fact that the rate of corrosion of lead in contact with sulfuric acid increases rapidly in the very low concentration range (0 to 5 percent). For example, at 2 percent, the rate is roughly twice that at 5 percent and may indicate premature failure.

In this connection, it appears that at low acid concentrations antimony-bearing lead alloy passivation can be attributed also to a sulfate of antimony.

In the case of lead linings, it would appear that with all else being equal, antimonial lead should be recommended in preference to chemical lead for improved service in the very low concentration area with optimum corrosion resistance expected at 3 percent Sb.

In the case of alum $Al_2(SO_4)_3$, lead is quite resistant to corrosion at the lower concentrations and normal temperatures, and at higher concentrations and temperatures as well. Such failures of lead as do occur in contact with these solutions are not generally the result of corrosion but rather mechanical failures due to improper design and installation, and accentuate the fact that methods of construction are particularly important in the case of lead.

New developments in lead construction over the past five years may be considered to comprise new innovations of established methods and what may be considered the current thinking on what comprises best practice. Accordingly, where different from that previously published or where worthy of repeated mention, a general treatment of each of the methods for installing lead for corrosives' service are given which contain information descriptive of the conditions which warrant selection of a particular method and procedures for implementing that method. In addition pertinent test methods are described.

**Bonded Lead Linings.** To obtain the greater efficiencies afforded in some cases by high operating temperatures and vacuum, bonded lead linings have been perfected and used with success for a great many years. The combined properties of steel and lead are used to advantage under any of the following conditions or combinations thereof with the thickness of the lead layer being dependent upon the ultimate use:

- Operation of vessels under vacuum.
- Rapid fluctuation in temperature which may make loose lead linings unsuitable because of fatigue.
- Conditions where heat transfer is important (absence of air gap).
- Where weight of brick-lead lining cannot be supported (elevated or very tall vessels).
- High temperatures which would produce excessive creep in loose lead

linings, (Bonded lead linings will not creep or crawl up to 232C. [450F.]) and where

- Vibration or repeated shock are encountered.

To accomplish fabrication of a bonded lead-lined vessel, in what constitutes an improvement over previously published methods consisting of burning bar and casting methods separately,[4] the more recent practices[5] combine gamma-ray inspection with the fabricating sequence to the extent that fabricators can produce defect-free homogeneously bonded lead linings at only a small increase in construction cost.

**Fabrication.** Initially the plates to be bonded are pickled on the lining side, presumably with a 30 percent solution of sulfuric acid, suitably fluxed (zinc-ammonium chloride and stannous chloride are two fluxes commonly used[1]) and heated on a furnace. Application of the "first coat" is made by rubbing a burning-bar on the treated steel and after coating the surface in this manner, molten lead is added until twice the finished thickness is obtained. The double thickness serves to float impurities with the excess, containing this matter, being disposed of by chipping after the lead-steel assembly is allowed to cool. The resultant roughened surface is subsequently smoothed by flame washing, an operation which serves to check for, remove, and repair minor defects. Peening follows, which results in a more dense and reduced grain structure.

At this stage of fabrication and before the lead-bonded steel is rolled to vessel diameter gamma ray inspection is used. Normal exposure techniques are utilized with proper allowances for the lead thickness in exposure time. All radiographs are made with a 100-mc cobalt-60 source with fine-grained high speed film, and source to film distance held at 12 inches for exposures on plate steel. After the lead lined sheets are rolled and welded together, a 2½-inch strip on either side of the weld is lead lined by hand-burning. This area is also inspected by radiography. Attachments are lined, welded to the vessel and finished off in a manner which is in accordance with general practice. The attachments are also radiographed with the source placed on the nozzle center line. The short distances involved result in maximum exposure times of 2 hours and in all cases the requirement of 2 percent sensitivity is met.

In interpreting films, very dark sharp markings indicate pinholes, gas pockets, or inclusions. Uniform general shading may be due to variations in lead thickness but if it begins or ends in a sharp line it warrants investigation. Dendritic or featherlike markings indicate the presence of slag or dross which should be removed. However, the latter markings are also indicative of an imperfect bond between lead and steel.

Radiography is carried out on a random or statistical sample basis with respect to the shell and heads. The nozzle necks are all radiographed 100 percent. Over-all cost of using this inspection method was found to be 5½ percent of the vessel fabrication cost. For 100 percent inspection, 10 percent of the vessel cost is estimated. In both cases, the added cost is small in terms of reduced downtime.

Other test methods which are not necessarily a part of the fabrication sequence include the "acid wash test" which is generally used to detect pinholing or porosity, ultrasonics relying on either resonance or pulse methods which are tests for bond discontinuity and for best results are conducted from the steel side only, and another method limited to pressure vessels.[3] The latter involves raising the internal temperature of the vessel by steam or other means to about 500F., cooling as rapidly as possible and examination of the lead surfaces for bubbles or raising which would indicate a lack of bond.

In service, testing and repairs usually involve visual detection of a leak followed by removal of lead from the affected area, building up of the damaged steel shell with weld metal, and homogeneous bonding of lead over the repair area. A test for tightness usually follows and is done simply by filling the tank with water and checking for leakage. Ultrasonics may also be used to advantage to determine the thickness of the shell at any point during service and before visual leakages occur.

**Sheet Lead Linings.** Sheet lead linings usually involve the lowest construction costs, mostly because they can be formed and joined in the field with a minimum of equipment and man hour expeditures. Lowest costs are realized when the sheet lead is hung from the top of a vessel shell but this is not always possible designwise and other innovations are used. These comprise strapping and several methods of fastening. However, in practice, the optimum height of a loose-lead-lined vessel without the benefit of strapping rarely exceeds 8 feet, depending on the weight of lead. In what is considered good vertical strapping practice, straps are placed about 18 inches apart and generally no more than 24 inches and subsequently covered with sheet lead thus presenting a continuous lead surface to the corrosive. Occasionally, large steel cut washers and round-head bolts are used to fasten sheet lead to the vessel shell which may be wood or steel. The bolt and washer in this case are covered with a lead cap which is welded to the lining. Bolts used in this manner are usually spaced over the lining on 18-inch centers.

In addition to bolting, fastening straps to support sheet lead linings more recently involve automatic stud welding which eliminates drilling of the steel shell and positioning of the lead sheet, with studs on 18-inch centers, 12-inch centers occasionally, but never more than 24-inch centers, and a comparatively new stud driver which eliminates drilling of straps and shell as well.

For both methods the advantages can be found in the following details of use.

- All fastenings made from inside of tanks.
- Elimination of outside scaffolding.
- Elimination of hole drilling.
- Elimination of countersinking of pre-drilled holes.
- Reduction in time-consuming marking by driving studs at random (not adhering to specific spacing.)
- Eliminates the bolting operation.

• In the case of the stud driving method, elimination of external power sources.

• Success in lining of a full range of tanks (⅛ to ¾ inch steel) and

• Actual job reports which indicate time savings of as high as 20 to 1 over the older method of drilling and bolting. Over-all cost savings have been about 60 percent and largely the result of lowered labor costs.

All in all when properly strapped or otherwise supported, sheet lead lined vessels can be used as reaction vessels where higher temperatures are encountered. In deep tanks, because of the high density of lead, loose linings must be strapped properly. When repairs are necessary they are easily accomplished and when the vessel's useful life has expired, the scrap value of lead constitutes a considerable reduction in the cost of new construction. Occasionally, in addition to strapping, a layer of acid-brick is placed over the lead lining on the bottom. The main purpose of this is to hold the lead in place and to prevent steam from open or ruptured coils from eroding lead. The prime difficulty with using this type of bottom is that it is often necessary to tear up a large amount of brick when a leak occurs in order to locate the leak. New techniques in the use of radiography have been developed, however. Pioneering in this work, Skiba and Bracken[6] of Esso Standard Oil Company and Deltor of Esso Research and Engineering Company found that radiographic inspection of lead-brick lined vessels is definitely feasible. They obtained radiographs that were useful in locating the cause of failures in a lead and brick-lined vessel, consisting of 3/16-inch lead bonded to ⅞-inch steel and covered with a 4½-inch carbon brick. A 500 millicurie cobalt-60 source was used at 36 inches, with a 12-hour exposure of an entire 24-inch manhole area. An extension of this technique to the aforementioned bottom construction is apparently feasible. As outlined later, radiographic techniques are especially useful as a means of avoiding the sometimes excessive loss in time due to unnecessary removal of the brick lining.

In the realm of inspection, sheet lead installations may be tested for imperfect welds or pinhole penetrations with fluorescent and dye penetrants. It has been found practical also, to pump suitably dyed kerosine between the lead lining and the vessel shell followed by inspection of the interior for kerosine traces. Still another technique involves pumping of freon-laden air between the shell and the lining with leaks on the inside of the vessel being detected by a halide torch.[3]

**Cage Construction.** A further extension and somewhat of an improvement in sheet lead construction is the so-called cage construction which has among its attributes:

- Easy leak detection.
- Permits repairs from the outside.
- Where the vessel design calls for extra support of the lead lining, internal strapping and corollary piercing of the lead for fastening is eliminated and
- Lower material and erection costs and easier field construction by elimination of unwieldy steel sheets.

It is customarily good practice to provide "weep holes" in the loose lead lined steel tanks but unfortunately the corrosives do not always follow a detectable path in the event of failure. Drippings cannot be depended upon to drain at the nearest weep hole and therefore they serve only to indicate the occurrence of a leak and not necessarily its location. The importance of leak detection and cage type construction therefore go hand in hand.

**Fabrication.** In place of the usual steel or wooden shell lined with sheet lead, a basket or cage-like structure comprised of steel flats and angles welded together to form an open frame is used for supporting the lead lining. Strips of lead are burned from the outside over horizontal steel straps, thus supporting the lead externally. Depending on the height of the vessel, the straps are closer together at the bottom than at the top to give the necessary support where hydrostatic pressure is greatest. Visual inspection for leak detection in most cases suffices. During fabrication defects may be detected by the applicable method previously outlined for sheet lead construction.

**Brick and Lead Linings.** An important method of construction for handling the most severe conditions is the use of a lead membrane between the steel vessel shell and an acid-brick inner lining. This type of construction has been proved effective in a large number of installations where lead by itself, or other materials of chemical construction, are inadequate. When properly designed and installed, they will perform admirably under the most severe conditions.

The following summarizes the conditions which warrant the selection of lead-brick construction and the experience acquired over the years which has contributed to its use, recognition of its value, and ultimately to extensive, widespread, and continued employment in the chemical processing industries:

- High temperatures: Bricking permits temperatures beyond the physical limitations of lead. Lead-brick construction is frequently used where the temperatures are in excess of 500 F. and even as high as 1000 C.
- High pressures and vacuum: Certain acid recovery units are brick and lead lined and operate under vacuums as low as 0.25 inch of mercury at about 260 F.
- Abrasion and erosion: Brickwork reduces the scouring effect of violent agitation found, for example, in sulfuric acid concentrators.
- Thermal insulation: Essentially eliminates heat loss and excessive temperature fluctuation as often encountered under rapidly fluctuating time-temperature cycles.
- Substantial cost savings: Ample proof of the economy of brick-lead combinations is the fact that corrosion resistant masonry construction composed of a suitable shell, lead membrane, proper brick work and cement can be depreciated over a long period of years, 15 years being not uncommon.
- Corrosion: Brick and lead perform very effectively over the range of sulphuric acid, alum, and acid-alum concentrations.

Here are some of the basic fundamentals which are observed in this

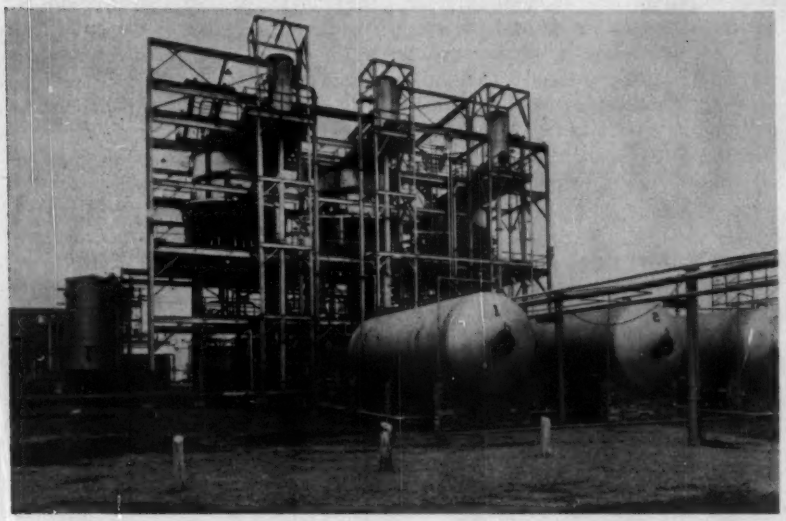

FIGURE 1—Three vacuum concentrators more than ten years old have been operating continuously on 40—92 percent sulfuric acid used for distillate treating.

type of construction in addition to the design of the tank which is built to support the weight of the entire structure:

**1.** Bottom should be dished where pressure is involved and the welds placed at or above the bottom edge.

**2.** The lead lining is applied after removal of all burrs and other projections on the inside of the tank which may cause injury to the lead. Chemical grade 8 to 10-pound sheet lead is usually adequate and is found in use generally.

**3.** The lead should be lapped over the top of the vessel to prevent seepage between the lining and the steel and loose sheet lead sides should be lapped over the bottom sheet about 4 inches and welded together around the entire exposed edge. In very large vessels, however, or at high operating temperatures, it is advisable to strap the lead to the outer shell. Inasmuch as lead will usually conform to the same general shape as the steel backing, it is desirable to obtain as smooth a steel surface as possible without abrupt changes in shape. At times bonded lead construction is required for reasons already outlined and surfacewise does not present a problem.

**4.** After the lead has been installed and tested, it is lined with one or two courses of brick chosen according to several factors, degree of acid resistance required, minimum allowable porosity and degree of thermal gradient of shock.

**5.** Furthermore, steps are taken to avoid contact with sodium ions in acid-proof cements. This is done by bonding asbestos paper to the lead with potassium silicate solution before the brick work is installed. Also a sheet of asbestos is utilized with resin base cements similarly. With sulphur-based cements an asbestos membrane is not needed.

**6.** A sufficient thickness of brickwork is installed such that temperatures at the surface of the lead will be reduced to 125 F. in the case of bonded lead, and 165 F. in the case of sheet lead. The temperature restriction for bonded lead is only applicable where tinning has been used for preparation of the steel surfaces. Skiba's treatment accomplished bonding without tinning at all, and in the method reported the temperature restriction does not apply.

**7.** With regard to another item on the thickness of the brickwork, an attempt is made to keep a sufficient thickness such that mean temperatures are reduced so that with increasing temperature the brickwork will be elongated more than the steel shell. The resultant differential expansion holds the lead in compression thus assuring more than adequate support.

With regard to testing, assuming faultless lead construction and no damage to the lead lining during the bricking-in process, with actual service, the procedures as recommended by Skiba and Bracken,[6] are recommended for expeditious handling of leakages as they occur. When properly utilized all but the necessary tearing up of brickwork is preventable. A variation in acid-brick and lead membrane construction may be seen in the accompanying Figures 1, 2, and 3.

**Other Developments.** To add further to the latest in lead construction practices, it is well worth noting the successful application of the technique of coating steel with lead by spraying.[3] This is done by spraying a mixture of finely divided metallic lead mixed with a volatile wetting agent at extremely low pressures with a high volume of air. When applied, the wetting agent evaporates out in a matter of minutes, leaving the metal deposited on the surface. The spraying operation is repeated twice more leaving a deposit of lead approximately 14 pounds to 80 square feet of surface or to a thickness of 10 mils over-all. This technique is now being used extensively in various installations throughout the U. S. to prevent corrosion of tubing and pipe, on the OD and the ID of tanks, oil treaters, gasoline plants, refineries, spray and cooling towers and structural steel work which are subject to corrosion encountered in the field. For example, lead applied in this manner has been in service in gasoline plant cooling tower piping as a protection against highly corrosive cooling water for more than 10 years with no signs of failure. It has also been used for interior protection of piping for secondary recovery systems for more than 15 years with the same results.

In the areas where lead pipe, valves, fittings and pump connections and lead return bends of sluice pipes find service in refining processes, lead has chalked up an impressive record. Very little can be added therefore with respect to these uses. Bonding techniques similar to those described

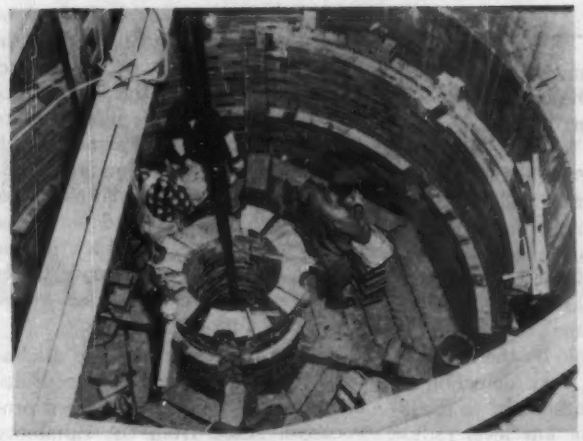

FIGURE 3—Lead lining further protected from corrosion by double acid-brick lining.

FIGURE 2—Vacuum concentrator body sections are lined with half-inch lead sheets.

can be used in the manufacture of lead lined steel pipe and lead covered copper heating coils with good results. Aside from the same general fluxing requirements, molten lead is cast on in sections by rotating the pipe. Another method involves inserting an extruded lead pipe into a suitably prepared steel pipe with the lead pipe being expanded against the outer shell by steam pressure. Temperatures which permit bonding are thus obtained. Lead covered copper pipe is fabricated similarly by variations of the casting method involving a mold.

**Informative Case History.** In this case history, there is excellent material on the sequence of events and steps taken in improving the serviceability of lead by proper design in an acid-alum reactor used in the production of aluminum sulphate (alum) as well as information on the various other uses for lead in this particular area.

**Introductory History.** Approximately 13 years ago, a total of 125 tons of lead was installed to handle the production of corrosive alum solutions in a bead catalyst plant where nearly two billion beads or 50 tons of finished catalyst per day are produced. The catalyst is used in the thermofor catalytic cracking process which at the time had recently come into extensive use in the production of high-octane gasoline. The beads are produced in lead lined forming towers from gel forming solutions consisting of sodium silicate and acid-alum (aluminum sulfate). Alum is produced in an acid-alum reaction tank from aluminum trihydrate reacted with sulfuric acid.

**Process.** Demineralized water is first introduced to the alum reactor whereupon sulfuric acid (66 degrees Bé) is added until the solution is 50 percent acid, filling the tank to a depth of 18 inches. The temperature resulting from the exothermic reaction is further increased by the addition of aluminum tri-hydrate (purified alumina) to 240 to 260 F. Additional alumina is added to maintain this temperature, and the reaction is continued for 1½ to 2 hours while continually agitated with steam which keeps the aluminum sulfate above its solidifying temperature of 210 F. After the reaction is completed, the batch is then diluted to make 23 percent aluminum sulfate which is kept for 4 hours at 130 to 140 F. Further dilution produces a 20 percent alum solution which fills the tank to 9/10 full and is liquid at room temperatures. The solution is then pumped out of the tank into a lead-lined solution preparation tank where it is further diluted to 10 percent. The average service of the reactor is one batch per day. It is readily seen that the combined effects of differential or cyclic heating, constant agitation, and abrasion and temperature level contribute to what is one of lead's severest tests.

**Equipment and Performance.** The reaction tank is 17 feet, 7 inchs on the ID and 7 feet, 3 inches in depth, and was lined initially with 16-pound chemical lead supported by vertical straps 4 feet apart. This proved unsatisfactory after only five months operation and was consequently ripped out. Severe physical distortion of the lead had occurred and subsequent penetation of the alum solution resulted in replacement of the steel bottom and sides to a height of 18 inches.

Since corrective steps were obvious and were dictated by the physical limitations of lead and not its specific resistance to the corrosive, a new tank lining was installed and put into service. Its bottom and sides were lined with 22-pound tellurium-chemical lead, and the slightly convex top, with 12-pound chemical lead. The additional straps consisting of half-oval steel covered by 16-pound tellurium-chemical lead 7 inches wide were installed to give support every 24 inches on the side wall in contrast with the original 48-inch spacing. The bottom was secured by parallel straps sheathed with 16-pound tellurium-chemical lead 16 to 18 inches apart and 5 inches wide bolted through the steel tank to supporting steel I beams beneath.

Repairs of this lining were not necessary until 16 months later when sporadic patching became increasingly frequent. All repairs were made with chemical lead rods. The walls showed the least amount of bulging or sagging between the straps, and required the least repairs. Corrosion was least in the lower third of the vessel wall but above that, the wall area was exposed to hot corrosive

foam in the presence of air, and some corrosion had taken place along the crests of the bulged lining. On the bottom, cracks and perforations had caused considerable trouble. Lead between the strapping had bulged in some cases as high as 3 inches above the tank bottom.

Trouble with the lining was severe because the product formed is liquid aluminum sulfate which seeps through occurring hair cracks into the cavity under a lead bulge, filling it, and later solidifying when the reaction ceases. Flattening of the bulges is prevented therefore and the bulge has to be cut open, and the solidified aluminum sulfate removed. Leaks were detected by weep holes; the presence of $Al_2(SO_4)_3$ being noted by the appearance of stalactites.

This difficulty at the bottom was due primarily to the appearance of fine cracks adjacent to the welded seams, on the seams, on or adjacent to welds from earlier repairs, or along crests of the bulges, a usually predominant occurrence.[7]

An attempt was made to correct the situation by using a brick lining to provide uniform support of the lining and also to insulate against the extremes of temperature and fluctuations thereof. However, the cementing compounds used did not withstand attack by the solution and eventually the bricks loosened and proceeded to swirl around causing damage to the lead lining (or membrane) and to the agitating equipment as well.

The reactor was later relined with a brick-lead membrane lining using a suitable cement. This trial installation after a few initial leakages remained in service practically trouble-free for five years. In fact, failures after five years of this type of service were expected. The only real difficulty presented at the time was not due to the repairs necessitated but rather to the difficulty encountered in finding the leaks. The weep holes were to no avail and the brick lining prevented the exact location of the leaks. Attempts made in repairing the lining resulted in a great wastage of man hours and extensive, unnecessary tearing up of different parts of the lining. In short, test methods at the time were insufficient to cope with the problem of locating a leak under a brick lining quickly.

In contrast to the situation 4 or 5 years ago, sufficient information has been reported in the literature as previously described which precludes the possibility of removing a serviceable lead-brick lining for want of sufficiently adequate test methods or techniques for determining the location of flaws or leaks.

Taking advantage of the techniques made possible by the advance of nuclear science, leak detection in lead-acid brick linings might be facilitated by the use of low level radioactive tracer-solvent methods which would depend upon the amplifying effect that a lead membrane would have on a gamma radiation-induced signal from a fluid source behind the lining. This could be accomplished by introducing a soluble radioactive element into water which would then be pumped between the lead membrane and vessel shell. Scintillation counters could be used to monitor the inside surfaces of the vessel in order to detect any intensification that would be indicative of a leak. After or before effecting repairs in this manner, detergent cleansing or chelation could be employed to remove vestiges of the tracer used.

Further use of such techniques may be had with respect to bonded lead linings or even sheet lead or cage construction and with or without brick. In this case, the vessel would be filled with the fluid source and the outer surfaces monitored to detect intensification of signals which would be indicative of imminent failure. However, calibration studies would be required and extensive measures may be necessary in the case of brick liners to remove traces of the radioactive constituent when it presents a problem.

Even considering possible limitations, the advantages of the aforementioned techniques are indeed provocative. Aside from the suitability of various test methods, installations similar to the one under consideration give up to 15 years' service. In short, lead lined alum digestors usually perform well from 9 to 11 years before the first leak occurs with the second often occurring between 10 and 15 years.

To sum up the situation at the bead catalyst plant, the bead forming towers lined with $\frac{3}{16}$-inch chemical lead supported by a single steel strap at the top are still unaffected by corrosion from the dilute acid and aluminum sulfate solution, 5 percent $H_2SO_4$, 5 percent $Al_2(SO_4)_3$, 90 percent demineralized water at room temperature, after 13 years service.

Lead lined storage tanks containing acid-alum solutions diluted to 20 percent strength, and solutions further diluted for introduction to the bead forming towers, are still giving good service to date after 13 years.

A large proportion of the piping in this installation is lead which has been extended beyond the design stress levels without eventful failure and is still in good shape attesting to the durability of lead in this application. Lead pipe, valves and fittings in pump connections and lead return bends of sluice pipes under forming towers are all showing excellent usage.

**About the Author**

**Edward J. Mullarkey** is technical director of Lead Industries Association, New York, where he gathers and correlates available technical information about all phases of lead usage. In addition, he disseminates this information so that it will be useful to government and industry, and will assist lead users in the solution of technical problems involving lead. He also investigates areas where research might be necessary or valuable, and generally supervises such research. Mullarkey is a graduate of New York University where he received a B.S. degree in metallurgical engineering. He was formerly with the Arma Division, American Bosch Arma Corporation.

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# How Much Nitrogen in Crudes from Your Area?

**Bureau of Mines survey gives the first complete data on nitrogen content of U. S. crude oils.**

**John S. Ball and W. J. Wenger**
U. S. Bureau of Mines, Laramie, Wyo.

VERY LITTLE crude of negligible nitrogen content is being produced in the U. S., according to the first comprehensive survey of nitrogen-bearing crude oils.

The survey shows that while nitrogen problems are most acute in California, they are also a factor in processing the petroleum production in most states.

Little factual information has been available previously to indicate the extent of the nitrogen problem. Nitrogen compounds in crude petroleum have become a problem to refiners with the advent of catalytic processing and will increase as more crude oil is subjected to catalytic processing.

The effects of nitrogen compounds on the catalytic processing of crude-petroleum stocks and on the stability of products produced from such oils have been shown to be deleterious.[2] These effects are serious enough that petroleum companies have devoted considerable research effort to the problem, and the American Petroleum Institute has established a fundamental research project (API RP 52) on nitrogen constituents of petroleum.

One reason for the meager data available on nitrogen contents of crude oils has been difficulty in determining nitrogen accurately. Successful determination of nitrogen in crude oil is a procedure requiring careful attention to detail. The difficulties were pointed out in a series of publications[3, 5, 6] and a better procedure was developed than had been previously available. Older data on nitrogen contents of crude oil do not agree among themselves and consequently cannot be considered reliable.

Since 1951 the Bureau of Mines has been accumulating nitrogen-content values as part of the routine crude-oil-analysis program. Results from the available analyses give an incomplete picture of the extent of nitrogen occurrence, but they do form a basis from which extrapolations may be made. If a complete story of nitrogen occurrence is to be obtained, additional information is necessary. Recognizing this, a paper[4] published in 1951 described methods for estimating nitrogen content from data previously included in the Bureau of Mines routine analyses. These methods, which are based on carbon residue values and geological data, were revised in 1957, and were presented at a recent meeting.[1] Results obtained by these procedures have been used to augment the actually determined nitrogen figures so that estimates for the entire country are more representative.

Table 1 shows the U. S. crude-oil production of 1955 divided into groups having different levels of nitrogen content. Almost one-fifth of the crude-oil production contains a high nitrogen content defined in this paper as 0.25 weight-percent or over. Most of this comes from California, but Oklahoma and Wyoming contribute appreciably. Another 23 percent of the total production has a nitrogen content in the moderately high, 0.1-0.25-percent range. This production has a much wider geographical distribution and brings the nitrogen problem to the attention of refiners throughout the country. Over half of the crude oil produced in 1955 had nitrogen contents between 0.01 and 0.10 percent. Less than 2 percent of the production had a nitrogen content below 0.01 percent.

Table 2 compares the nitrogen contents of crude oils produced in 1940 with those produced in 1955. The pattern is remarkably similar, despite increases in production over the 15-year span. The division into groups hides one significant point. In 1940 the petroleum from California with high nitrogen composed 95 percent of the nation's high-nitrogen oil, while in 1955 it composed only 74 percent.

The weighted average nitrogen contents of crude-oil production by states for 1940 and 1955 are shown in Table 3. These averages are obtained by multiplying the production for each field in a given area by the nitrogen content and dividing the sum of these values by the production for the area. A similar calculation for the U. S. showed that the average nitrogen content had decreased from 0.178 to 0.148 in the period 1940-55. This change can be misleading, because the difference is chiefly due to the lessening importance of the California oil production in the national average. Several important producing states, including Oklahoma, Wyoming, Kansas and Texas, showed significant increases in the average nitrogen content of their production. It should be noted that the large change noted for Nebraska had little effect on the national average because the high value shown in 1940 was based on a small total production.

States showing an average nitrogen content greater than the national average in 1955 were California, Kentucky, Oklahoma and Wyoming. While California is the only state with an

## Nitrogen in Crude Oils . . .

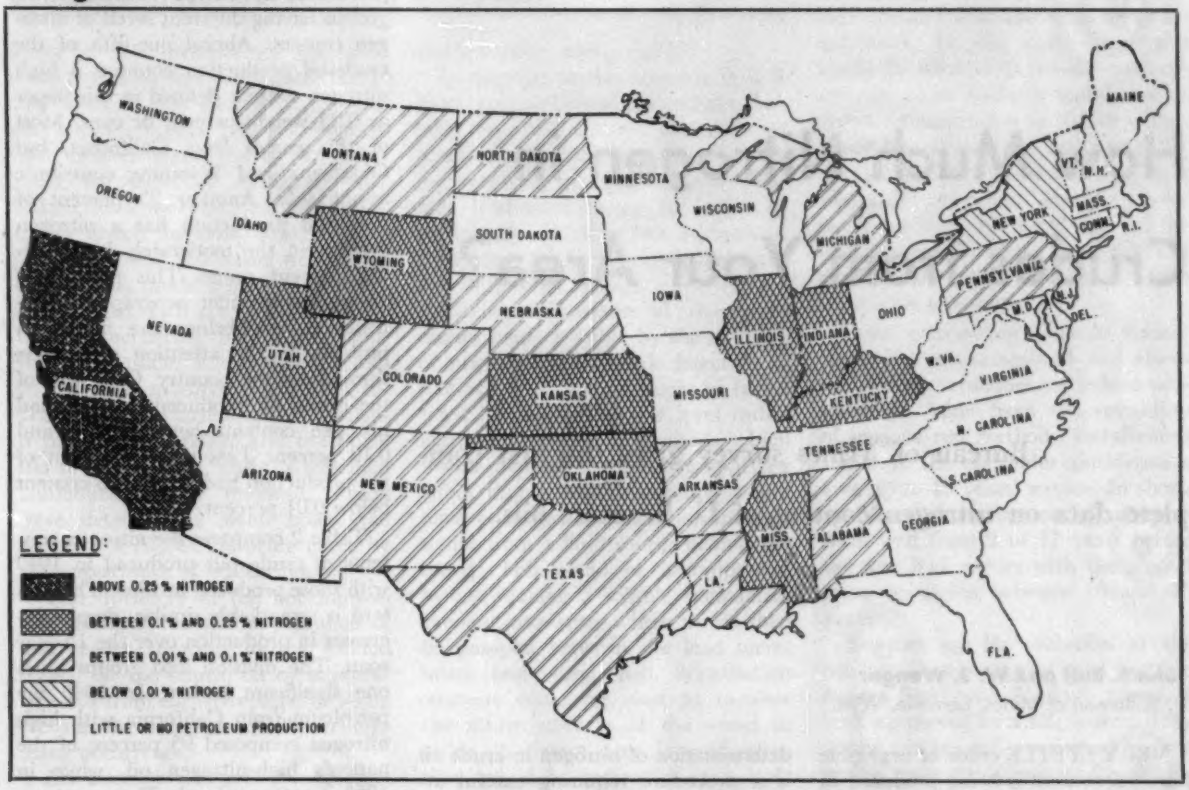


FIGURE 1—Geographical distribution of nitrogen-bearing crude oils.

**TABLE 1—Nitrogen Content of U. S. Production of Crude Petroleum for 1955**

| STATE | 1955 Production Thousand Barrels | Petroleum Production in Thousand Barrels, Containing Nitrogen (W. Pct.) in Range | | | |
|---|---|---|---|---|---|
| | | 0.25 and Over | 0.1 to 0.25 | 0.01 to 0.1 | Below 0.01 |
| Alabama | 1,377 | .... | .... | 1,377 | .... |
| Arkansas | 28,506 | .... | 6,915 | 20,679 | 912 |
| California | 354,737 | 339,675 | 11,102 | 2,148 | 1,812 |
| Colorado | 51,018 | ..... | ..... | 48,160 | 28,458 |
| Illinois | 81,610 | ..... | 62,286 | 19,324 | .... |
| Indiana | 11,089 | ..... | ..... | 11,089 | .... |
| Kansas | 121,869 | 4,269 | 91,057 | 26,543 | .... |
| Kentucky | 15,297 | ..... | 12,341 | 2,956 | .... |
| Louisiana | 268,233 | ..... | 31,051 | 232,740 | 4,442 |
| Michigan | 11,267 | ..... | 4,708 | 6,559 | .... |
| Mississippi | 37,280 | ..... | 18,422 | 18,858 | .... |
| Montana | 15,613 | 593 | 3,436 | 11,382 | 202 |
| Nebraska | 9,854 | ..... | 5,383 | 4,471 | .... |
| New Mexico | 82,398 | ..... | 30,418 | 50,131 | 1,849 |
| New York | 2,904 | ..... | ..... | ..... | 2,904 |
| North Dakota | 11,155 | ..... | 3 | 11,152 | .... |
| Oklahoma | 203,337 | 76,695 | 32,389 | 94,253 | .... |
| Pennsylvania | 8,423 | ..... | ..... | 8,423 | .... |
| Texas | 1,058,720 | 4,600 | 227,609 | 806,726 | 19,785 |
| Utah | 2,058 | ..... | 1,777 | 141 | 140 |
| Wyoming | 100,473 | 31,333 | 30,560 | 38,580 | .... |
| Other | 7,315 | [1] | [1] | [1] | [1] |
| Total | 2,484,533 | 475,165 | 569,457 | 1,415,692 | 34,904 |
| Total (percent) | 100 | 18.4 | 22.9 | 57.0 | 1.4 |

[1] Nitrogen not defined.

average nitrogen content above 0.25 percent, Wyoming, Utah, Kansas, Oklahoma, Mississippi, Illinois, Indiana and Kentucky all have averages above 0.1 percent. Figure 1 shows the geographical distribution of nitrogen-bearing petroleums. The widespread occurrence of nitrogen-containing crude oils is apparent.

Table 4 shows the basis for the 1955 data in Tables 1, 2 and 3. This table shows, by states, the percentage of oil for which determined nitrogen values were available and the percentage for which nitrogen values could be estimated. In each state the oil on which no data were available was assumed to follow the same pattern as in areas for which data were available. This is a greater extrapolation than is desirable, but the distribution of samples geographically suggests that no area producing large quantities of oil or oil of unusual characteristics was overlooked. The combination of the results for the individual states shows that, for the U. S., determined values were available for 37 percent of the production, estimated values could be obtained for another 22 percent, and the assumed values applied to 41 percent.

As shown in Table 5, the data for 1940 are somewhat firmer than those for 1955. Analytical results were available for more of the crude oils that were in production at that time. The figures for 1955 include many newly discovered fields for which analyses are not available.

It should be recognized that the nitrogen values discussed here are for the crude oil and that, in many processing schemes, 85-95 percent of the nitrogen would be in the residual fuel oil, asphalt, and coke. However, as the tendency to go "deeper in the barrel" for distillate products continues, the nitrogen affecting processing will increase.

To summarize, the presence of nitrogen compounds in crude petroleum has become a problem to refiners with the advent of catalytic processing. This problem will be increased as greater percentages of the crude oil are subjected to catalytic processing. California crude oils have by far the highest nitrogen contents, but the problem is not confined to California because many areas of production have significant nitrogen values. There appears to be very little crude oil production in which the nitrogen is negligible.

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## About the Authors

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**John S. Ball** is chief, branch of petroleum region 3 for the U. S. Bureau of Mines, Laramie, Wyo., where he directs petroleum research in the Rocky Mountain states. Ball received his B.S. degree in chemical engineering from Texas Technological College in 1934, and his M.S. degree from the University of Colorado in 1936. He joined the Bureau of Mines in 1938, and since then has worked in crude oil analysis, sulfur in petroleum, shale oil composition, and nitrogen compounds in petroleum.

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**TABLE 2**

**Comparison of nitrogen content of crude-oil production of 1940 and 1955**

| | 1940 | | 1955 | |
|---|---|---|---|---|
| | Thousand Barrels | Percent | Thousand Barrels | Percent |
| Total production | 1,351,847 | 100 | 2,484,533 | 100 |
| **Production Containing:** | | | | |
| Over 0.25 percent nitrogen | 228,138 | 17 | 457,165 | 18 |
| Between 0.1 and 0.25 percent nitrogen | 297,092 | 22 | 569,457 | 23 |
| Between 0.01 and 0.1 percent nitrogen | 796,949 | 59 | 1,415,692 | 57 |
| Below 0.01 percent nitrogen | 22,964 | 2 | 34,904 | 2 |
| Nitrogen not defined | 6,704 | .. | 7,315 | .. |

**TABLE 3**

**Weighted average nitrogen content (wt.-pct.) of crude-oil production by states**

| STATE | 1940 | 1955 |
|---|---|---|
| Alabama | .... | 0.062 |
| Arkansas | 0.085 | .085 |
| California | .501 | .490 |
| Colorado | .071 | .042 |
| Illinois | .133 | .126 |
| Indiana | .120 | .120 |
| Kansas | .122 | .144 |
| Kentucky | .157 | .157 |
| Louisiana | .041 | .056 |
| Michigan | .057 | .057 |
| Mississippi | .105 | .105 |
| Montana | .054 | .079 |
| Nebraska | .270 | .099 |
| New Mexico | .109 | .082 |
| New York | .006 | .006 |
| North Dakota | .... | .039 |
| Oklahoma | .085 | .151 |
| Pennsylvania | .029 | .029 |
| Texas | .066 | .074 |
| Utah | .125 | .125 |
| Wyoming | .125 | .183 |
| United States | .178 | .148 |

**TABLE 4**

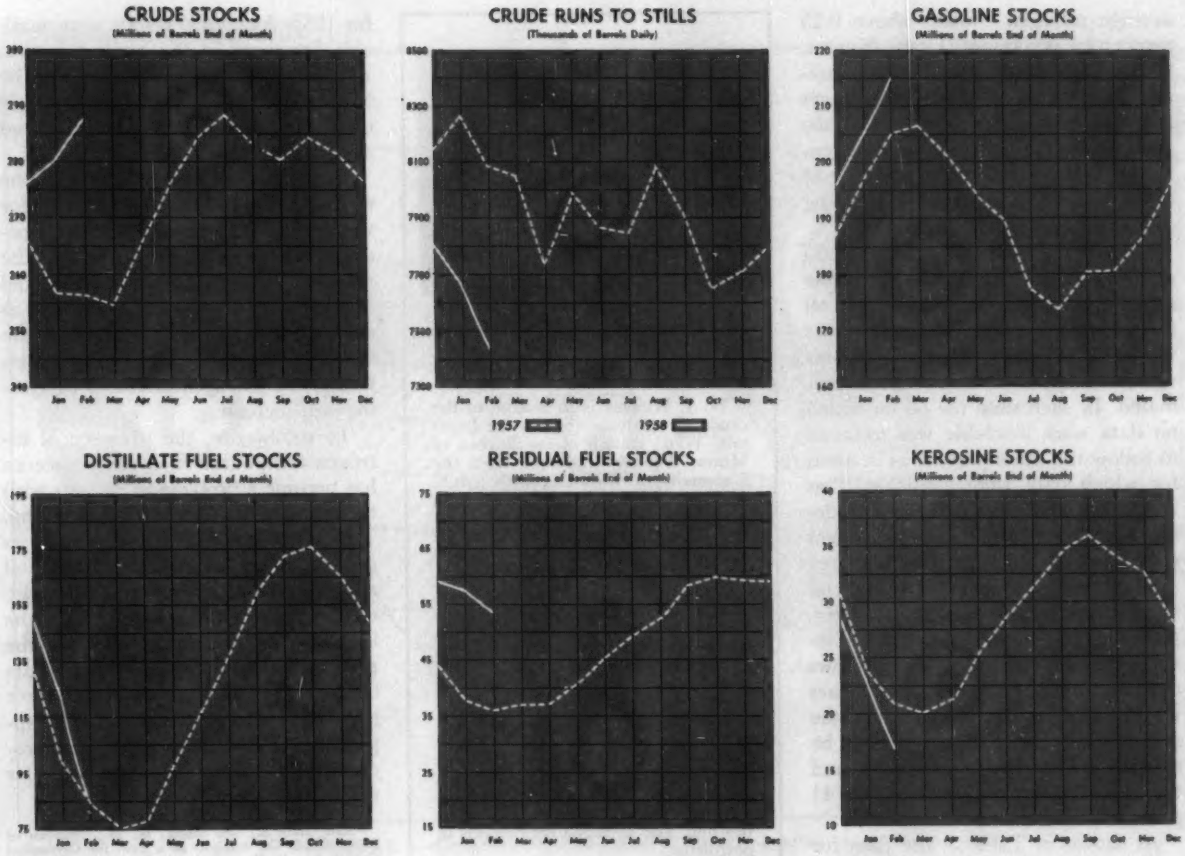
**Extent of available data for calculating nitrogen content of petroleum production for 1955**

| STATE | Percent of Total Production | Percent of Total Production for Which— | | |
|---|---|---|---|---|
| | | Nitrogen was Determined | Nitrogen was Estimated | Nitrogen was Assumed |
| Alabama | 0.1 | 63 | 0 | 37 |
| Arkansas | 1.1 | 29 | 39 | 32 |
| California | 14.3 | 72 | 14 | 14 |
| Colorado | 2.1 | 85 | 0 | 15 |
| Illinois | 3.3 | 14 | 29 | 57 |
| Indiana | .4 | 21 | 0 | 79 |
| Kansas | 4.9 | 9 | 25 | 66 |
| Kentucky | .6 | 15 | 8 | 77 |
| Louisiana | 10.8 | 9 | 45 | 46 |
| Michigan | .4 | 10 | 15 | 75 |
| Mississippi | 1.5 | 52 | 10 | 38 |
| Montana | .6 | 86 | 0 | 14 |
| Nebraska | .4 | 88 | 0 | 12 |
| New Mexico | 3.3 | 39 | 25 | 36 |
| New York | .1 | 78 | 0 | 22 |
| North Dakota | .4 | 93 | 0 | 7 |
| Oklahoma | 8.2 | 29 | 11 | 60 |
| Pennsylvania | .3 | 0 | 85 | 15 |
| Texas | 42.6 | 32 | 24 | 44 |
| Utah | .1 | 66 | 0 | 34 |
| Wyoming | 4.0 | 75 | 0 | 25 |
| Other | .3 | 0 | 0 | 100 |
| United States | 99.8 | 37 | 22 | 41 |

**TABLE 5**

**Method of obtaining data for nitrogen content of U. S. crude-oil production**

| | 1940 | 1955 |
|---|---|---|
| Determined results—percent | 41 | 37 |
| Estimated results—percent | 29 | 22 |
| Assumed results—percent | 30 | 41 |




# Taking Stock

- Gasoline Stocks At All-Time High
- Fuel Oil Inventories Continue to Drop
- Crude Runs at 3-Year Low

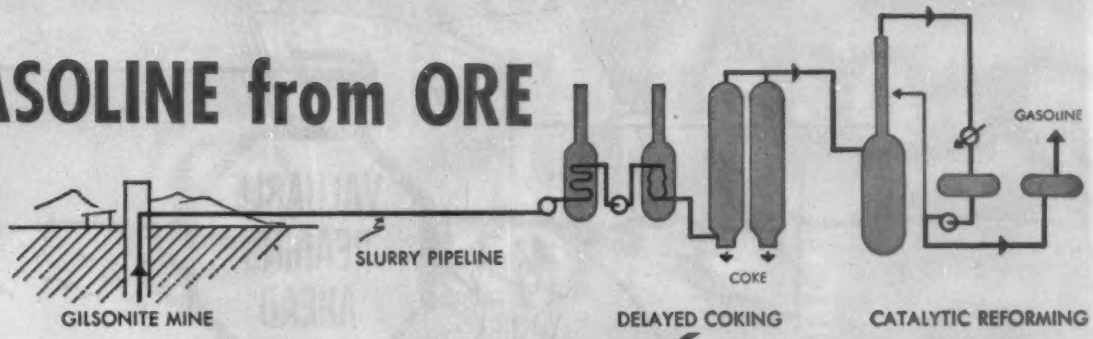
| MONTH | CRUDE OIL | | | GASOLINE | | KEROSINE | | DISTILLATE FUEL | | RESIDUAL FUEL | | DAILY IMPORTS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Production Daily | Runs to Stills Daily | Stocks End of Month | Production Daily | Stocks End of Month | Production Daily | Stocks End of Month | Production Daily | Stocks End of Month | Production Daily | Stocks End of Month | Crude Oil | Total Oils |
| **1956:** | | | | | | | | | | | | | |
| February | 7,208 | 8,047 | 259,504 | 3,854 | 196,092 | 385 | 18,712 | 1,918 | 71,335 | 1,286 | 35,673 | 878 | 1,472 |
| March | 7,278 | 7,914 | 265,683 | 3,829 | 199,698 | 342 | 17,215 | 1,808 | 60,846 | 1,213 | 32,984 | 934 | 1,426 |
| April | 7,146 | 7,487 | 277,121 | 3,646 | 193,299 | 299 | 18,227 | 1,713 | 63,571 | 1,130 | 32,740 | 815 | 1,305 |
| May | 7,064 | 7,896 | 277,497 | 3,859 | 186,673 | 292 | 21,883 | 1,667 | 75,928 | 1,149 | 36,607 | 938 | 1,416 |
| June | 7,100 | 8,071 | 274,491 | 3,976 | 177,076 | 290 | 26,111 | 1,755 | 93,758 | 1,098 | 39,073 | 987 | 1,426 |
| July | 7,090 | 8,014 | 277,008 | 3,975 | 176,536 | 296 | 28,990 | 1,767 | 115,787 | 1,066 | 43,958 | 1,084 | 1,463 |
| August | 7,195 | 7,995 | 279,944 | 4,037 | 172,939 | 313 | 31,826 | 1,839 | 137,905 | 1,091 | 46,617 | 1,001 | 1,399 |
| September | 7,054 | 8,024 | 278,791 | 3,991 | 177,974 | 329 | 33,588 | 1,845 | 150,411 | 1,062 | 47,342 | 1,043 | 1,452 |
| October | 6,966 | 7,608 | 286,560 | 3,773 | 172,798 | 356 | 35,667 | 1,772 | 158,871 | 1,083 | 48,400 | 1,004 | 1,541 |
| November | 7,139 | 8,031 | 275,995 | 3,913 | 174,808 | 384 | 34,329 | 1,841 | 151,517 | 1,182 | 44,590 | 871 | 1,362 |
| December | 7,377 | 8,141 | 266,014 | 4,039 | 187,271 | 379 | 31,420 | 1,981 | 133,981 | 1,288 | 44,491 | 873 | 1,471 |
| **1957:** | | | | | | | | | | | | | |
| January | 7,480 | 8,274 | 256,669 | 3,991 | 197,702 | 367 | 24,019 | 2,113 | 100,572 | 1,322 | 38,403 | 805 | 1,425 |
| February | 7,682 | 8,088 | 256,344 | 3,864 | 205,270 | 353 | 21,013 | 2,035 | 85,105 | 1,270 | 31,201 | 780 | 1,430 |
| March | 7,717 | 8,047 | 254,911 | 3,826 | 206,716 | 332 | 20,223 | 1,861 | 76,245 | 1,205 | 37,371 | 836 | 1,464 |
| April | 7,541 | 7,740 | 265,796 | 3,770 | 201,407 | 284 | 21,512 | 1,764 | 78,743 | 1,132 | 37,429 | 906 | 1,542 |
| May | 7,442 | 7,992 | 275,963 | 3,900 | 195,094 | 272 | 25,545 | 1,789 | 98,135 | 1,103 | 41,125 | 1,042 | 1,558 |
| June | 7,107 | 7,867 | 284,312 | 3,984 | 190,063 | 254 | 28,872 | 1,773 | 117,364 | 1,101 | 45,572 | 1,147 | 1,606 |
| July | 6,873 | 7,852 | 288,241 | 3,887 | 177,868 | 249 | 31,713 | 1,750 | 138,359 | 1,090 | 49,621 | 1,220 | 1,654 |
| August | 6,786 | 8,092 | 283,388 | 4,122 | 174,031 | 252 | 34,576 | 1,806 | 159,124 | 1,089 | 52,645 | 1,257 | 1,695 |
| September | 6,887 | 7,920 | 280,469 | 4,009 | 180,688 | 276 | 36,382 | 1,772 | 173,269 | 1,100 | 58,727 | 1,042 | 1,445 |
| October | 6,860 | 7,650 | 284,517 | 3,930 | 180,902 | 265 | 34,384 | 1,705 | 176,388 | 1,052 | 60,025 | 1,022 | 1,532 |
| November | 6,824 | 7,692 | 281,769 | 3,901 | 187,141 | 324 | 32,696 | 1,734 | 166,763 | 1,069 | 59,622 | 902 | 1,455 |
| December | 6,929 | 7,816 | 281,813 | 4,001 | 196,776 | 356 | 29,200 | 1,886 | 149,449 | 1,142 | 59,959 | 1,130 | 1,909 |
| **1958:** | | | | | | | | | | | | | |
| January | 6,883 | 7,661 | 280,601 | 3,832 | 205,057 | 362 | 22,951 | 1,855 | 122,325 | 1,067 | 57,520 | 955 | 1,550 |
| February | 6,821 | 7,447 | 287,780 | 3,756 | 215,222 | 371 | 17,232 | 1,721 | 87,978 | 1,086 | 54,293 | 801 | 1,443 |
| **Week Ending:** | | | | | | | | | | | | | |
| 3-21-58 | 6,263 | 7,316 | *283,846 | 3,571 | 216,907 | 336 | 17,178 | 1,655 | 78,449 | 1,028 | 55,013 | 1,020 | 1,568 |
| 3-22-57 | 7,818 | 7,976 | *251,921 | 3,580 | 205,521 | 324 | 19,978 | 1,836 | 77,603 | 1,023 | 36,886 | 697 | 1,256 |

*Data are for one week earlier.

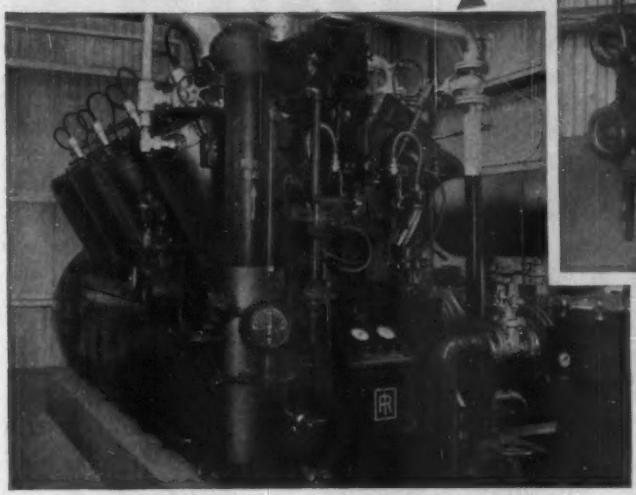
**Source:** Data, for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

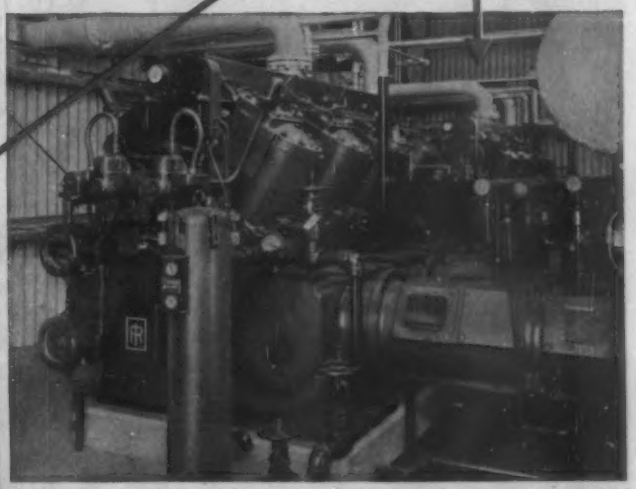
# American Gilsonite's new refinery extracts

# GASOLINE from ORE




## *Ingersoll-Rand SVG and JVG gas-engine compressors serve new process*





Two Ingersoll-Rand 220-hp JVG-NL gas-engine compressors handling pure hydrogen for the catalytic reformer unit of the Gilsonite plant. The hydrogen is kept free from oil contamination by use of non-lubricated compressor cylinders with Ingersoll-Rand NL Channel Valves.

One of two Ingersoll-Rand 550-hp SVG 4-cycle gas-engine compressors handling hydrocarbon gas in the delayed coking section.

They're mining gasoline ore in Utah these days, and an old company in a new refinery is producing new products from it.

In addition to high-octane gasoline, the American Gilsonite Company* at Gilsonite, Colo., is producing high-purity electrode coke from this asphaltite ore. This ultra-modern coking and reforming plant is the nation's first to produce gasoline economically from a raw material other than crude oil, and it's doing it at the rate of 54,600 gallons a day!

Gas compression is required in both the delayed coking and catalytic reforming units, and since by-product hydrocarbon gases were available, Ingersoll-Rand gas-engine compressors were a natural selection for both jobs. The coke-producing unit, engineered by Foster Wheeler, uses two 550-hp SVG compressors; the refining unit, engineered by H. K. Ferguson, is served by two 220-hp JVG non-lubricated compressors.

In this new service as in all process plant applications, service-proved dependability and smooth operation over a wide range of speeds and loads make Ingersoll-Rand 4-cycle V-angle gas-engine compressors a profitable, long-term investment. Ask your I-R representative for more information about these and other types of equipment for petrochemical and process plants.

*An affiliate of Barber Oil Corp. and Standard Oil Co. of Calif.

Only IR compressors have CHANNEL VALVES

Known for high efficiency, quiet operation and exceptional durability. Entirely different. Each valve is a combination of straight-lifting stainless-steel channels and leaf springs, with trapped-air spaces which cushion action, prevent impact.

**Ingersoll-Rand** 4-CYCLE

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PUMPS • COMPRESSORS • VACUUM EQUIPMENT • GAS & DIESEL ENGINES • AIR & ELECTRIC TOOLS • ROCK DRILLS

## Safety Rules and Talks

Accidents cause hardships and lost man hours. That's why you'll want to read the review of "Safety Rules and Talks." This book may hold the answer to your special problem in plant safety. To learn the details . . .

**Keep Going to Page 327**

## News Flashes!

That's what you get when you read "Changing Times," the section that gives you the news after it has been boiled down until just the bare essentials remain. It's fast moving—it's quick—and above all, it's accurate. You'll see for yourself when you read "Changing Times."

**Keep Going to Page 278**

## Portable Flanging Furnace

You'll want to read about the unique way four men in Atlantic Refining Co.'s Philadelphia boiler shop created a portable sheet steel flanging furnace. There are also many other helpful hints on how to get things done. It's all there in this month's "How To Do It."

**Keep Going to Page 214**

## Who's Building

Great progress is being made on new refinery installations. You'll want to keep well informed on the latest developments and "Who's Building" is written to see that you are.

**Keep Going to Page 223**

## Centennial Coming!

A section in PETROLEUM REFINER's January, 1959, "Oil Centennial" issue will be set aside for 15 to 20 men who have made the greatest contribution to the oil processing industry. You, as one of REFINER's thousands of readers, may play an important role in selecting them. The details are on the green card, last page, plus a space for your nomination.

**Keep Going to Page 351**

## It's Boxscore Time Again

Yes, this month PETROLEUM REFINER again presents "Construction BOXSCORE," the quarterly tabulation of refinery-petrochemical-natural gasoline plant construction projects from all over the world. You'll find it real easy to keep pace with who's building what, where, by studying "Construction BOXSCORE"—the most complete and up-to-date guide to building in the industry.

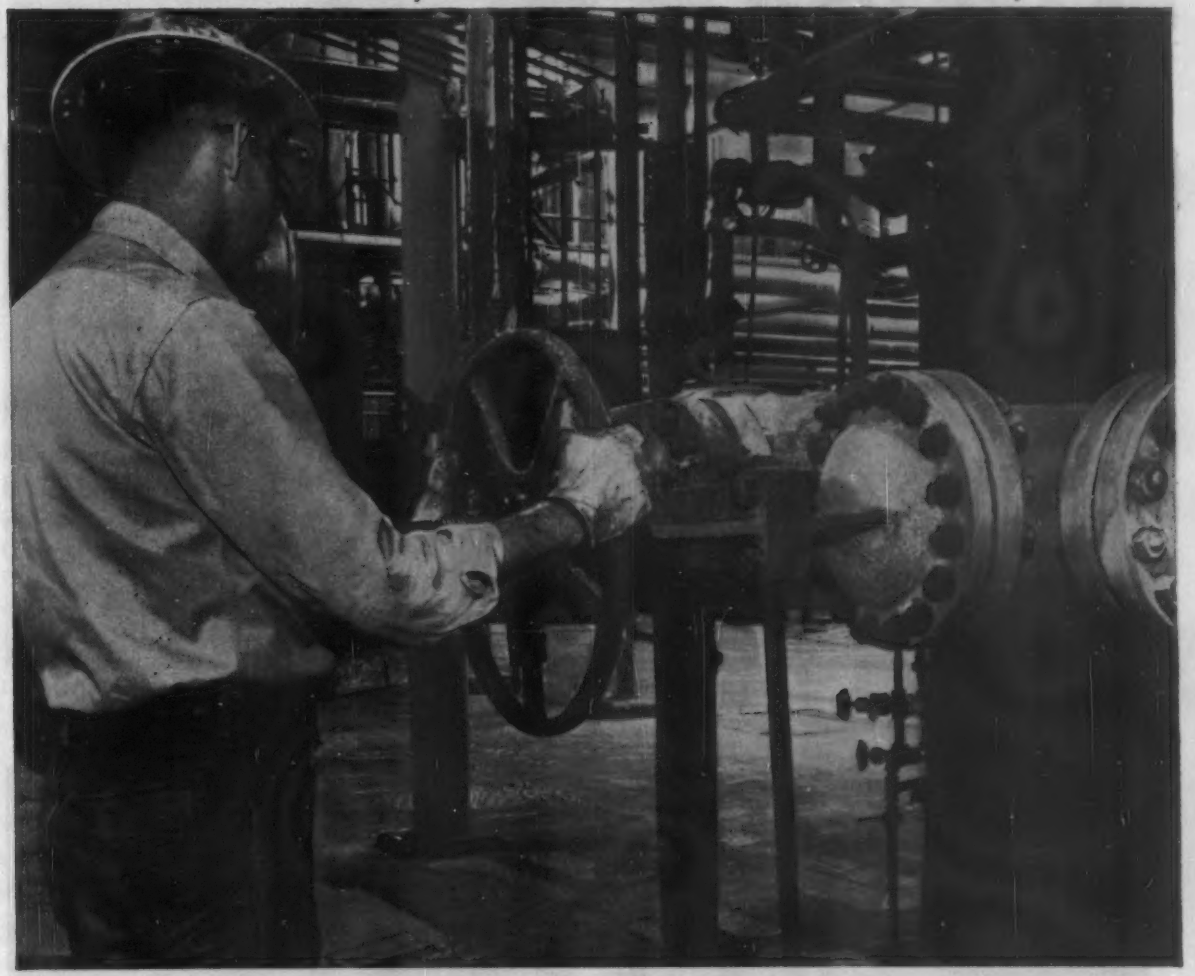
**Keep Going to Page 231**

## Are You There?

Say . . . are you listed in "What's Happening Among Men in the Industry?" If you've been promoted or have changed jobs lately, then you're probably listed. If you're not there this month, however go ahead and read it anyway—it's packed with news of the people you went to school with, and those who work around you. Don't miss it!

**Keep Going to Page 280**

Another refinery knows Crane steel valve durability



## How to insure steady control of hot oil for seventeen years plus

There's no guesswork in this refinery's hot-oil valving. Quality comes first and foremost in its valve buying.

The block valve shown being operated on Continental Oil Co.'s thermal cracking unit at Lake Charles, La., was installed in 1941. Working at 830 deg. F., this Crane 8-inch, 300-pound steel gate has never been out of the line for repair.

Except for routine lubrication and repacking when needed on turn-arounds, maintenance through the past 17 years has been of a very minor nature. Still this Crane valve is leak-free, completely dependable, operates with ease.

On steel valves—on all valves and fittings for refinery needs—Crane is the name that assures real, long-term values and protects against unreal price-tag savings.

A fact to remember in today's squeeze on your company's profit.

**THIS FREE BOOK**—"Valve Performance Facts"—gives you 32 examples of savings with quality valves. Get a copy from your local Crane Representative, or write to address below.

# CRANE VALVES & FITTINGS

**PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING**

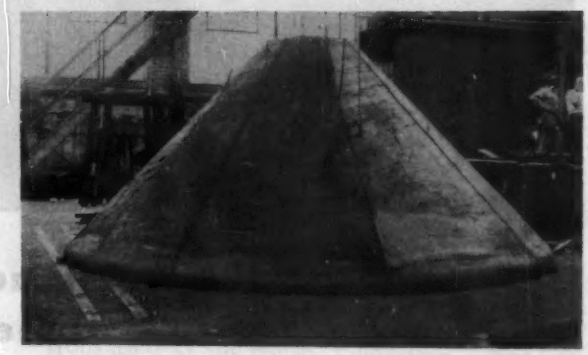
*Since 1855 — Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas*

# How To Do It . . .

Furnace heats agitator segment . . .

. . . then it's flanged on a bed plate

## Portable Furnace Speeds Atlantic's Flanging Operation



. . . and welded to others forming the bottom.

Four men in The Atlantic Refining Company's Philadelphia boiler shop had an idea for a portable sheet-steel flanging furnace.

The boiler shop was frequently called on to fabricate cone-shaped agitator bottoms. Pieces of sheet metal, cut like pie segments, have to be flanged before being welded together to form the finished cone. Previously, a furnace lifted by an overhead hoist was used to heat the ends of the pie segments preparatory to flanging.

A portable furnace, mounted on casters and easily adjusted for height and angle was made for this specialized job. The furnace is shown heating one of the agitator segments which has been bolted to a bed plate for ease in performing the flanging operation when the metal has reached an almost white heat.

The finished agitator bottom, with all segments welded, was fabricated in fewer working hours and in a safer manner because of the portable furnace frame that started out as an idea and ended up as a reality.

Idea and photographs courtesy *The Atlantic Magazine*, a publication of The Atlantic Refining Company, Philadelphia, Penn.

## Duckbill Pliers Ease Fastening Of Acid Shields

Modern plastic shields to prevent acid drip from flanges present a problem when snapping them in place.

The shields are constructed so that a snap, which is moulded as an integral part of the shield, can be fitted into a hole for an acid tight joint. The difficulty is that the snap offers slightly more resistance for a tight joint than the operator can apply with his fingers. When using ordinary pliers, the snap is easily broken as it is forced through the hole or the shield

# More light on producing hydrogen economically ...Tidewater uses heat-resistant Incoloy tubing

The hydrogen plant at Tidewater Oil Company's new Delaware Refinery is the first such unit ever built to supply a refinery's desulfurizer. Capacity is 30 million cubic feet of hydrogen per day.

**High temperature-pressure problem**

Metal temperatures in the reformer furnaces are in excess of 1700° F with internal pressures of the reacting gases sufficiently high to emphasize the need for strength and ductility. To provide these properties, the tubes in one furnace are made of extruded Incoloy* nickel-iron-chromium alloy.

**Incoloy is the solution**

Incoloy alloy exhibits high creep strength and rupture strength combined with satisfactory ductility. It is not susceptible to embrittlement resulting from structural changes after prolonged heating. Of special importance in containing hydrogen under pressure is the ability of the alloy to provide welds of high integrity. Furthermore, when used in the extruded form, the alloy offers decided economies over other materials.

Incoloy alloy is also used here in the reformer heater outlet manifold and reformer outlet to desuperheater.

For more information, or for help with a high temperature or corrosion engineering problem of your own, write Inco's Development and Research Division.

*Registered trademark

**The International Nickel Company, Inc.**
67 Wall Street New York 5, N. Y.

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PERFECT SEAL
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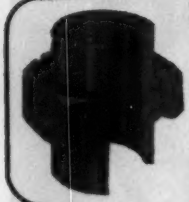
A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!



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Available with screwed or socket weld ends. 3000-lb. sizes ⅛" to 3"; 6000-lb. sizes ⅛" to 2".

ORIFICE UNIONS
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

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With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

FULL STAINLESS & FULL ALLOY STEEL UNIONS
With screwed or socket weld ends. 3000-lb. and 8000-lb. service.

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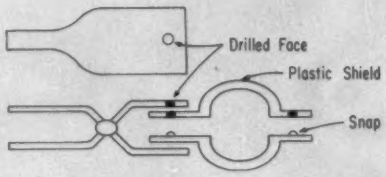
showing the complete Catawissa line of Perfect Seal Products

CATAWISSA VALVE AND FITTINGS COMPANY
60 MILL STREET • CATAWISSA, PENNA.

## How to Do It . . .

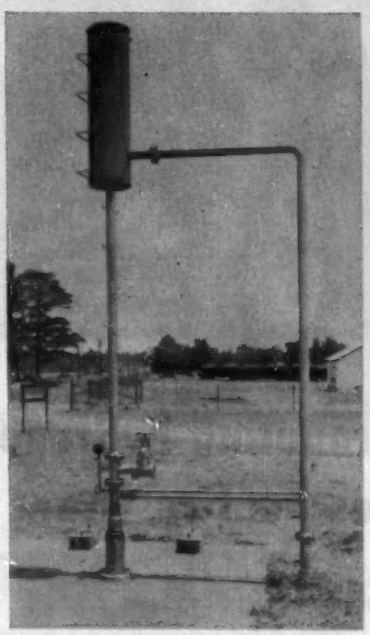
itself is torn.

A simple solution is to drill a hole in one face of a pair of duckbill pliers that will allow the snap to protrude through its mating hole and into the drilled face of the pliers. Thus the




snap is fully inserted in the hole, assuring an acid-tight joint and the operation can be carried out quickly with no damage to the shields.

Idea submitted by J. L. Dooly and C. A. Pfeiffer, Ethyl Corporation, Pasadena, Texas.



## Separator Made From Scrap For Gas Lift Waterwell

Where air pressure is used to jet water wells, a neat hookup may be made by mounting the air-water separator directly above the well head. This provides gravity flow of the discharge water and if gas is used for lifting, it will be dissipated high in the air.

The water well is completed and tubed in the usual manner and a jet is installed in the bottom with a 1-inch line leading to the pressure source. Instead of stopping at the top of the well head, the 4-inch line is extended as far as necessary into the air in order to get the water flow to the top of the storage tank. A ladder is placed on the side of the 4-inch line so that the operator can go up and look into the top of the separator and see exactly how the well is behaving.

The separator is made from a piece of 12-inch pipe, open at the top, with a 4-inch outlet near the bottom to carry the water away. A 2-inch brace with a union in it is welded between the wellhead and the outlet line to keep the unit steady, but this line is blanked off and does not carry any water. By having the separator directly above the well, the maximum efficiency in the air or gas lift system is obtained.

Idea submitted by Harry Hess, Havana, Cuba.

## Novel Means Adds Ink Supply to Recording Meter

Where the differential pressure on a recording meter varies from minute to minute, the red ink supply must be augmented by having more capacity than is provided with the standard pen. A novel, simple means of hold-

# Here's why saran lined pipe cuts installation costs

*It's easy to fabricate, easy to install at job site . . .*
*and it resists corrosion for years*

Here is a corrosion-resistant pipe that can be fabricated in the field. Saran lined pipe can be cut and threaded at the job site with conventional hand tools or power equipment. And, once installed, saran lined piping systems resist corrosion for years . . . offering proved long-range economy.

For piping acids, alkalies, solvents and other corrosive fluids specify saran lined pipe, fittings, valves, and pumps with the new gray lining. This new lining anchored under pressure within the steel casing, enables you to pipe fluids over a wider range of temperatures than ever before . . . with maximum protection from corrosion, plus the strength of steel.

Saran lined pipe, fittings, valves, and pumps are available for systems operating from vacuum to 300 psi, and from well below zero to 200°F.

If your operation can benefit from a *complete* corrosion resistant piping system, write today for more information about saran lined piping components. And be sure to ask about Saraloy® 898 tank lining, too! THE DOW CHEMICAL COMPANY, Midland, Michigan.

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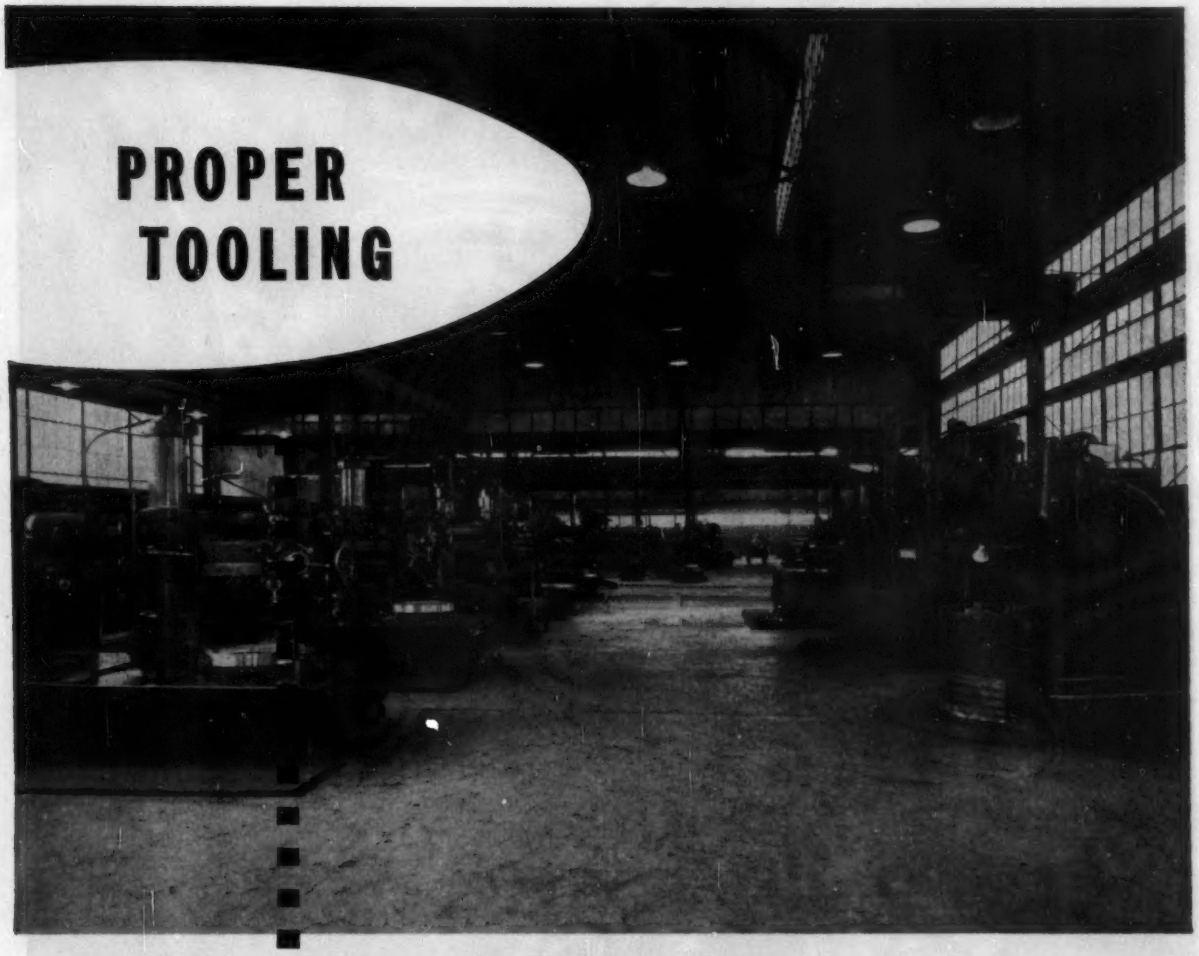
YOU CAN DEPEND ON DOW



For more data on advertised products, use Readers' Service Cards, last page.

# PROPER TOOLING



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- service-proved engineering design
- guaranteed job ratings
- complete fabricating facilities
- technical service before, during and after installation

One reason that Efco does it *right* is its many years of experience in designing and fabricating heat-exchangers for the wide range of temperatures and pressures represented by ethylene plants and platinum catalyst reforming units. We are recognized specialists in handling all grades of carbon, alloy, and stainless steels, nickel, aluminum, and special low-temperature materials.

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*Engineers and Fabricators, Inc.*

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ing more ink in the red pen may be devised by taking two openbacked, static pen points, sticking them together and putting them in the differential pen arm, along with the red pen included with the meter. By placing the static pens back-to-back and inserting one of the points in the back of the differential pen, three times the ink capacity is obtained and the necessity of inking the pens between chart changes is eliminated.

Idea submitted by:
Harry Hess, Houston

## Smudge-Free Trip for Work Orders in Plastic Film

Transparent film envelopes made of polyethylene are being used by engineering companies to protect traveling work orders as they are routed through plants and offices. These protective envelopes are clear so that orders can be read easily without removing the papers. A simple, quick pressure closure permits papers to be taken out and replaced if the work order needs notation. With the pressure closure sealed, the work order is protected against dirt, chemicals, moisture and finger smudges. Film made of polyethylene is highy resistant to moisture penetration, chemical attack and abrasion. The pressure closure, also made of polyethylene, consists of two small interlocking ridges that give a complete seal. To open the enevelope, it is merely necessary to lift one flange to disengage the lock. An added feature of the work order envelope is the slot at the top which can be used to hold identification of the originating department or supervisor.

Idea submitted by:
Bakelite Co.

**YOUR IDEAS ARE VALUABLE!**

**At least $10 will be paid for each idea accepted for "How to Do It." Just send a brief note with a photo or sketch to the Editor, *Petroleum Refiner*, P. O. Box 2608, Houston.**


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HELIQUAD® PUMPS
Ask to Pump the "Impossible"

THREE IMPELLER DOUBLE HELICAL ROTOR

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KINNEY Heliquad Pumps are designed specifically to handle materials beyond the capabilities of other pumps . . . heavy viscous materials, principally, that pumps of other configurations just do not handle economically. Asphalt, tar, heavy crudes, Bunker and even gasoline are handled efficiently. Heliquads are fixed displacement Pumps and will give metered flow . . . volumetric range from 10 to 2000 gpm.

The economy advantage in the KINNEY Heliquad is based on two factors: 1) freedom from downtime and high maintenance over exceptionally long service life, (many in operation over 20 years); 2) heat economy—Heliquad Pumps move heavy viscous materials at substantially lower temperatures, (the fact the high heat is available doesn't change the fact that btu's cost money).

Heliquad Pumps handle entrained gases and nonlubricating liquids. They make money for you by doing the job other pumps can't do—by keeping production up when other pumps are *down*. Write for Bulletin L-54 Today!

Get the facts on the pump, and rotor that is best for you.

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For more data on advertised products, use Readers' Service Cards, last page.

*Heat exchanger photo courtesy The Atlantic Refining Company, Philadelphia, Pa.*

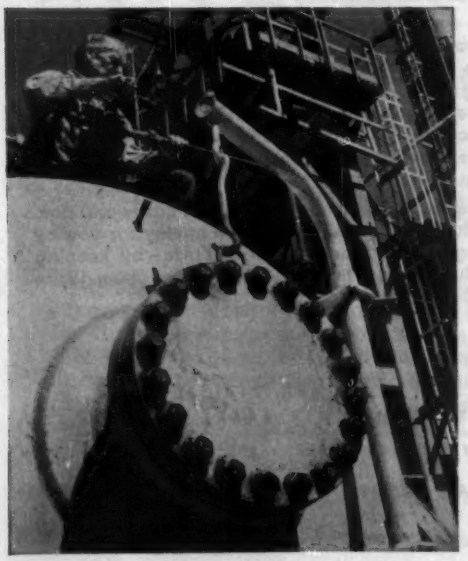
# Republic ELECTRUNITE

## *Gives You a Good,*

It's easier, more economical to roll-in Republic ELECTRUNITE® Heat Exchanger Tubing because you get a good, tight seal every time. That's why more and more refineries and processing plants are using Republic ELECTRUNITE for original equipment and for retubing operations.

Here's why: Republic ELECTRUNITE provides uniform wall thickness and true concentricity to give the user better control. And it speeds retubing operations, too.

To begin with, ELECTRUNITE Heat Exchanger Tubes are formed from flat-rolled, high quality, open-hearth steel, carefully checked for chemical analysis, physical properties, exact thickness and width, and freedom from scale and surface defects. ELECTRUNITE Tubing is "electrically-welded" with no foreign metal added.



**REPUBLIC ALLOY STEEL STUDS AND HIGH CARBON HEX NUTS** resist high temperatures, high pressures, corrosion... three common causes of stud failure. Clean accurate threads provide maximum holding power, resistance to wear. Specify Republic on your next order.

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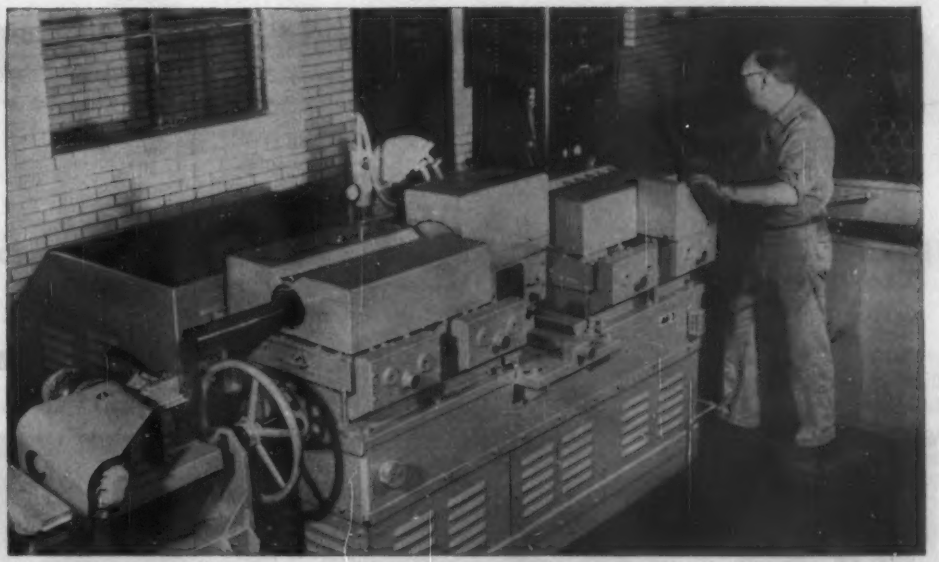

**FARROWTEST.** Tubes move through a group of test coils. Signal remains constant as long as tube is uniform and free from irregularities. Only Republic offers this "eddy current" type non-destructive test as an alternate to hydrostatic testing, at no extra cost.

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Each length is normalized above the upper critical limit to relieve stresses; to induce softness; to alter ductility, toughness, electrical, magnetic or other physical properties; to refine the crystalline structure or to produce a definite microstructure. Actually, the carbides go into solid solution and during controlled cooling the carbides disperse evenly throughout the structure.

After straightening, each length is hydrostatically... or FARROWTESTED® (Republic's exclusive non-destructive electronic test) to conform to the applicable code requirements.

If you want to learn more about how you can keep your heat exchanger operations in service at lowest cost, call your nearest Republic representative... or write today.

**REPUBLIC "DEKORON®-COATED" E.M.T.** saves costs of electrical raceway maintenance under severe corrosive conditions. Tough, polyethylene coating over galvanized finish gives double protection to electrical raceways. See your electrical supplier or contractor.

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Firm _____

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City _____ Zone _____ State _____



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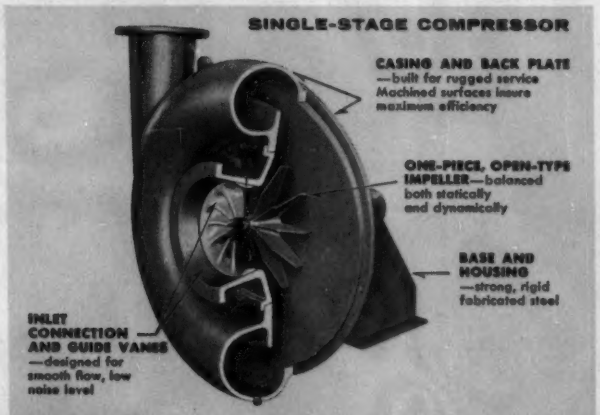
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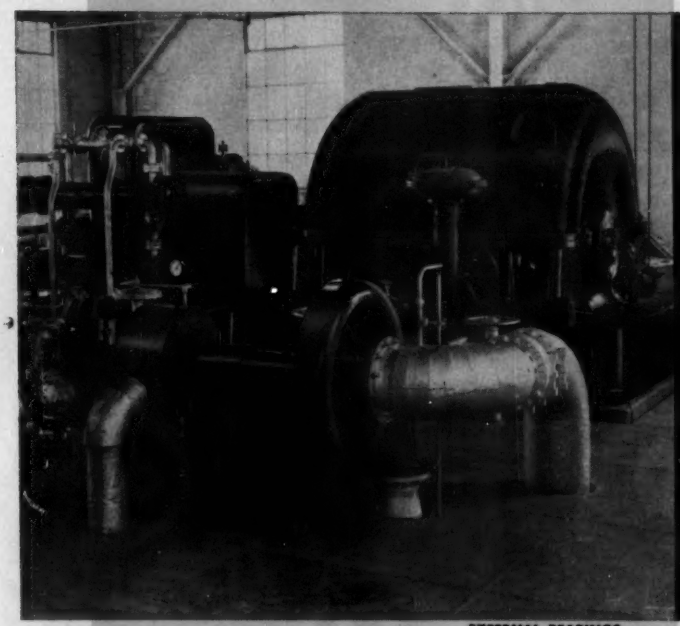
***Whether Single-stage or Multistage...***



# ELLIOTT CENTRIFUGAL COMPRESSORS

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Elliott centrifugal compressors are available with inlet capacities up to approximately 150,000 cfm. For complete details, write Elliott Company, Compressor Department, Jeannette, Pa.

The Elliott centrifugal compressors in this installation photo are servicing a fluid catalytic cracking unit. They illustrate the flexibility of Elliott-engineered machines which are specifically designed to their applications.

The multistage machine in the background is the main air compressor, which compresses 61,000 icfm of atmospheric air to 29.4 psia in the process of lifting and regenerating the catalyst. It is driven by an Elliott 5000-hp multistage steam turbine. The single-stage compressor in the foreground is the control air compressor and it handles 3750 icfm of air from 28.9 to 33.2 psia. It is driven by an Elliott 116-hp turbine.

**ELLIOTT Company**

P7-6

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# Who's Building . . .

# More Capacity for Chile Refinery Soon

**Atmospheric and vacuum distillation will give ENAP an additional 24,000 bpd.**

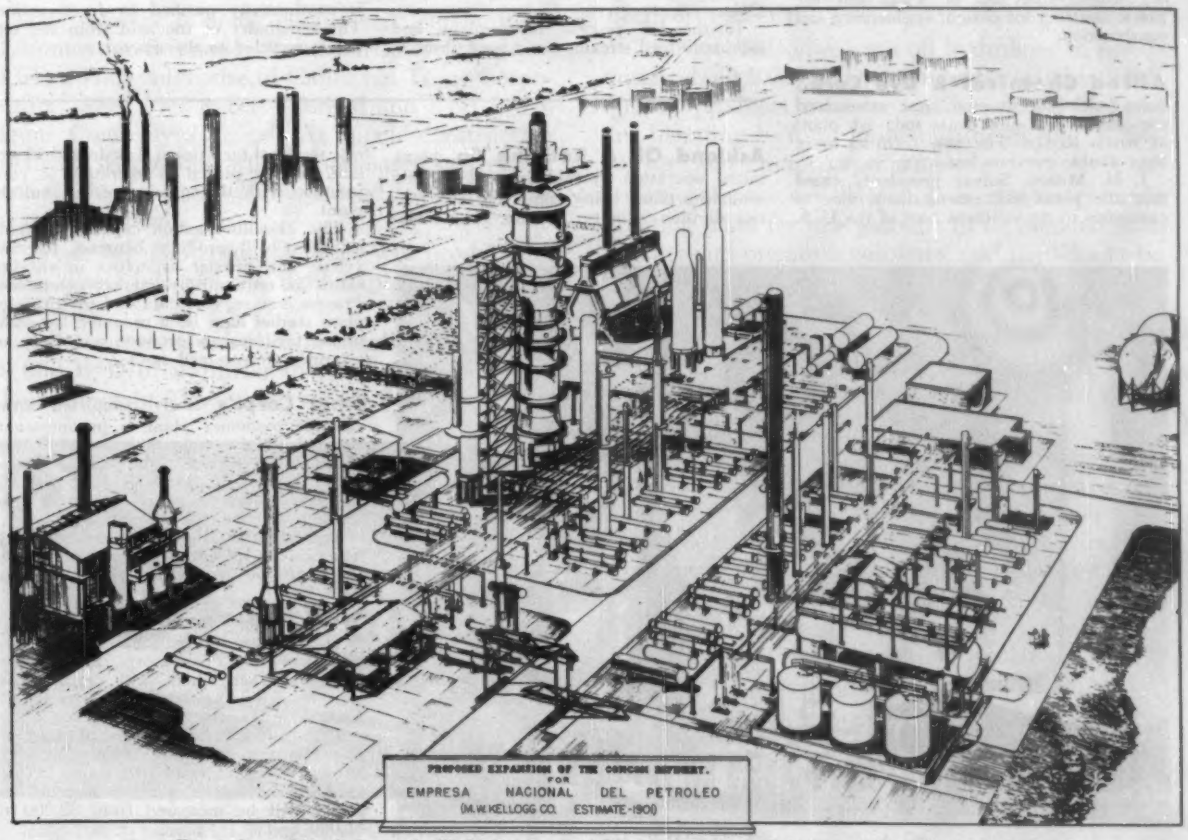
Capacity of Empresa Nacional Del Petroleo's (ENAP) Concon, Chile refinery, will be expanded by 24,000 bpd through the addition of three new units. These will be a 24,000 bpd atmospheric and vacuum distillation unit, a 12,000 bpd Orthoflow fluid cat cracker and gas recovery unit and a 6,000 bpd cat desulfurization and reforming unit and a 1,100 bspd Alkylation Unit. The boiler plant facilities will be expanded as well.

New boilers supplying 450 bsid 725F steam, a complete boiler feed water treating system and a new turbo generator will comprise the boiler plant extension.

The atmospheric and vacuum distillation unit will be capable of processing either Magallanse or Medium Officina crude oils. The Orthoflow cat cracker and gas recovery unit will operate at 60 percent conversion and will also be capable of operation at 48 percent conversion and at reduced capacity. The alkylation unit will produce aviation grade gasoline.

Low octane naphtha distillate will be charged to the desulfurization and reforming unit to obtain a high octane reformate. Part of the gas produced will be recycled and the balance will be sent to the gas recovery unit. Before entering the reforming section the naphtha will be desulfurized.

Process, mechanical and design engineering and procurement for the expansion will be by the M. W.




**Expansion will include crude distillation, cat cracking, reforming, alkylation and desulfurization.**

## Who's Building...

Kellogg Co., New York, a subsidiary of Pullman Inc. Construction will be handled by ENAP, with Kellogg's subsidiary, Kellogg Pan American, providing supervisory personnel. Initial operation will be under supervision of Kellogg Pan American operating engineers.

ENAP's existing 20,000 bpd Concon refinery was designed and engineered by The M. W. Kellogg Co. and constructed by ENAP under the supervision of Kellogg Pan American Corp. construction personnel. Initial operation was under the supervision of Kellogg Pan American's operating personnel. The existing processing at the refinery involves an integrated combination of crude topping, reduced crude visbreaking, gas oil cracking, thermal reforming, vacuum reduction of tar, gasoline stabilization, gas recovery and LPG production.

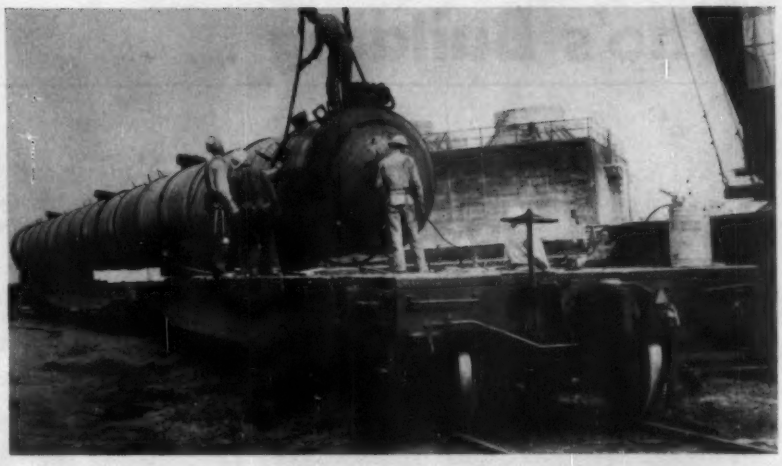
**Deere and Co.'s** Grand River Chemical division is adding an ammonia-recovery plant at Pryor, Okla., to recover 10 to 15 tons daily of ammonia now being vented into the air.

The Grand River plant is producing 260 tons a day of urea from natural gas. Loss of ammonia occurs at two stages, first in a recycling process and later as the urea is handled further along in the system. The new plant will pick up these waste materials and return them to the system for processing.

Completion of the project is scheduled for the fourth quarter of 1958. The Refinery Engineering Co. of Tulsa has the prime contract for design, engineering and construction.

**Allied Chemical & Dye Corp.,** Solvay Process division, has announced completion of a new dense soda ash plant at Baton Rouge. The new facilities more than double previous capacity.

I. H. Munro, Solvay president, stated that the plant will extend its service to customers in the southern part of the U. S.



Motor fuel alkylate will go through deisobutanizer to recover isobutane for recycle.

## Champlin Gets HF Alky Unit at Enid

Contractor for Champlin Oil and Refining Co.'s new HF alkylation unit, Badger Manufacturing Co. of Cambridge, Mass., announced that the Enid Okla,. plant was on stream approximately four weeks ahead of schedule and is running smoothly. Badger handled engineering and construction of the plant.

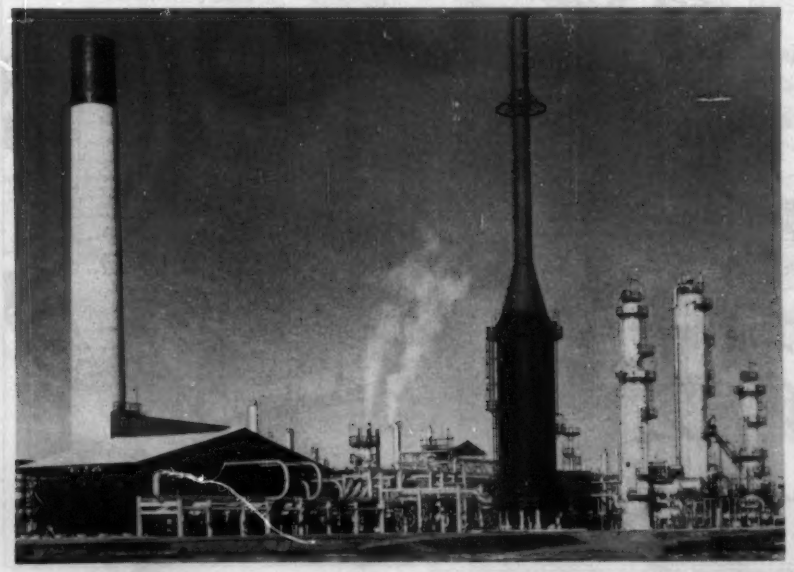
The 1430 bpd-hydrofloric acid alkylation unit which will be use the Phillips process, will become a part of Champlin's Enid, Okla. refinery.

In the HF process, dried olefin and isobutane feed streams are passed through separate dryers, then are reacted with liquid hydrofluoric acid. After the alkylation reaction is completed, the hydrocarbon and the recycle acid flow to a settler where a two-phase separation occurs. The hydrocarbon phase is charged to the fractionation section (de-isobutanizer) where the recycle isobutane is separated from motor fuel alkylate. A small portion of the acid phase from the settler flows to an acid return unit where the HF acid catalyst is continuously purified by fractionation. The remainder of the acid from the settler is recycled to the reactor.

---

**Ashland Oil & Refining Co.** plans initial operation by mid-April of its new aromatics plant being completed at Frontier division refinery, Buffalo, N. Y. Marine terminal facilities at Toledo and Cleveland will be placed in operation in conjunction with the opening of the Buffalo plant.

The 21-million-gallon capacity aromatics plant will produce benzene, toluene, xylene and heavier aromatics in varying ratios as required by market conditions. Process designs, cost data and several pilot plant studies have been prepared for additional facilities to produce a variety of intermediates or feed stocks.



Tidewater Oil Co.'s expansion of Avon refinery includes a 22,000-bpd catalytic reformer.

**Ethyl Corp.'s** newly completed vinyl chloride monomer plant is in operation. Located in the company's Baton Rouge manufacturing center, the vinyl chloride monomer will be produced by cracking ethylene dichloride, which is made by the reaction of ethylene and chlorine.

Contractor for the engineering and construction of the vinyl chloride plant was Catalytic Construction Co. of Philadelphia.

**Standard-Vacuum Oil Co.** has awarded Fluor International, S. A., a subsidiary of The Fluor Corp., Ltd., a two-phase contract which will permit Stan Vac to raise the crude capacity of its Australian refinery by 25 percent.

The contract calls for substantial improvements to Standard's Altona refinery, located 15 miles from Melbourne. When finished, the refinery's crude running capacity will be increased from 32,000 to 41,000 bpd.

In the second phase, Fluor will engi-

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# LUMMUS BUILDING $30-MILLION REFINERY AT WHITEGATE, IRELAND

## New 40,000 B/D Installation for Irish Refining Co., Ltd.

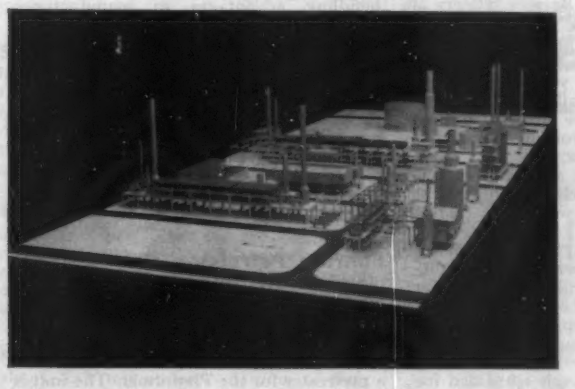
## Latest of 19 built by Lummus throughout the world since end of World War II

In the Whitegate area of County Cork, Ireland, a new refinery is now being constructed to meet the increasing demand for oil products.

The refinery is being engineered and built by Lummus for the newly formed Irish Refining Co. Ltd., a joint enterprise of California Texas Corporation, Shell Mex & B.P. Limited and Esso Petroleum Company Limited. As much construction material as possible will be purchased in Ireland, and Irish nationals will be trained to operate the completed plant.

Crude oil distillation facilities will produce jet fuel, diesel oil, fuel oil, light naphtha and other products.

A Powerforming Unit will catalytically reform 9,000 B/D of naphtha to produce 100-octane Powerformate. The unit will include a special hydrofiner to eliminate sulfur compounds from the raw feed stock, and light end facilities. This Powerformer is the only high octane processing unit needed to meet the projected marketing demands.



Model used by Lummus Ltd. in engineering of Whitegate Refinery.

There will also be a gas oil hydrofiner to desulfurize about 6,000 B/D of crude gas oil, the desulfurized products to be used for autodiesel fuel and for blending to form industrial diesel fuel, turbo-jet fuel and tractor vaporizing oil.

Other features will include a copper chloride treating plant for raw gasoline to be blended with regular and premium gasolines, and naphtha to be blended into turbo-jet fuel, regular gasoline and tractor vaporizing oil; facilities for about 10,000 B/D of crude naphtha; and facilities for blending gasolines and adding anti-knock compound. Most of the plant will be air-cooled so that little or no cooling water will be required.

With the completion of this project in 1959, Lummus will be responsible for an impressive percentage of the new refining capacity constructed throughout the world over the past ten years. The experience gained in these projects, as well as in designing and constructing a wide variety of over 700 other plants in the last 50 years for the process industries, is at your disposal. If you have a project in mind, we will be glad to discuss it with you.

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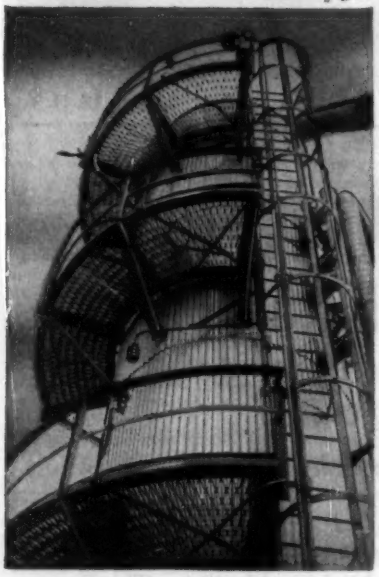

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## Who's Building...

neer and construct a new sovafiner. Engineering work has been started on both of these projects with construction to begin in July. Both units are scheduled for completion in 1959.

**British Petroleum Co.'s** Kent Oil Refinery on the Isle of Grain, England, has a new distillation unit which increases its annual capacity from 94,000 bpd to more than 144,000 bpd.

The unit is the first major plant to come on stream in the refinery's $84-million expansion project. When completed later this year the refinery will be able to produce about 2,600 bpd of aviation gasoline and an increased quantity of other oil products. In all, 21 new processing units will be commissioned at the refinery between now and August.

The project also includes two new main jetties, extensions to the boiler and power plant, and the erection of 122 new storage tanks.

**Japanese Synthetic Rubber Co., Ltd.,** organized recently to establish a synthetic rubber industry in Japan, has been licensed to construct Houdry Process Corp.'s dehydrogenation process unit.

The new Japanese unit will be part of an integrated synthetic rubber plant to be built in the Yokkaichi vicinity. The Houdry unit will be designed to produce 25,000 short tons per year of butadiene, which when supplemented by other butadiene sources will produce 45,000 metric tons per year of synthetic rubber.

Varying feedstocks will be charged to the new Japanese dehydrogenation unit, including refinery butanes and butane-butene mixtures from petrochemical plants. Engineering design for the dehydrogenation unit is being furnished by Houdry Process Corp. It is estimated that the entire plant will come on stream in 1960.

**Esso Standard Societe Anonyme Francaise** will expand its petroleum refining and petrochemical manufacturing facilities at Port Jerome, France. The new units are a detergent alkylate plant, a chemicals plant designed to produce ethylene, butadiene, and other chemical raw materials, a plant to produce additives for lubricating oils, and propane dewaxing expansion. Foster Wheeler Corp. will provide mechanical design and construction.

**Standard Oil Co.'s** Bayway refinery at Linden, N. J., has rock miners deep beneath it drilling the country's largest man-made storage caverns.

When completed this year, the network of underground rock-wall caverns will be capable of holding more than 28 million gallons of liquefied petroleum gas.

Mined at a minimum depth of three hundred feet below the surface, this network will eventually include 6,000 linear feet of tunnels most of which are 13 feet wide and 22 feet high.

Work on the Bayway refinery underground LPG storage caverns began in October, 1956, when a drilling rig was put into operation to bore the main shaft.

The first cavern, capable of holding 300,000 barrels of propane gas, has been virtually completed. The second, for 375,000 barrels of butane gas, is scheduled for completion in the near future.

The propane and butane will be stored in a liquid state under pressure. The solid rock walls will be the only container. When they are completed, the caverns will be sealed off and filled—never to be entered again.

When completed, the caverns will consist of two networks of honey-comb tunnels. These are the first mined caverns for the storage of petroleum products on the East Coast.

A company of Tulsa, rock-mining specialists, Fenis and Scisson, Inc., is the general contractor on the project. The drilling was handled by the Layne New York Co.

**North Star Oil Co., Ltd.,** has awarded Procon (Canada) Ltd. a contract for the construction of a combination UOP Platforming-Unifining unit at its St. Boniface, Manitoba refinery. Awarding of the contract is one of the first steps in an extensive expansion program North Star will carry out there. Cost of the project is expected to be in excess of $1 million. Nominal design capacity of the Platforming section is 2,700 bpsd. Universal Oil Products Co. designed and licensed the combination unit.

**Continental Oil Co.** is revamping a single-reactor reformer into a full-scale reformer to upgrade gasoline octanes at its 10,500-barrel Billings, Mont., refinery.

The existing reactor has been used as a hydrodesulfurization unit to produce hydrogen. After the revamp, it will also produce about 1,500 bpd of high-octane gasoline components. The Refinery Engineering Co. of Tulsa has the design, engineering and construction contract.

**U.S.S.R.,** in a report on the 1958 plan for development of its economy stated that a new shale plant with a capacity of 4 million tons a year is to be erected at Kokhtla Yarve. This would insure fuel for the new Baltic power station now under construction in the same area. The new plant should be capable of extracting some 500,000 tons of oil a year.

**B. F. Goodrich Chemical Co.** has announced that the first facility in the country for making glacial acrylic acid in large commercial quantities is nearing completion at its plant in Calvert City, Ky.

Located on a two and one-half-acre portion of the company's Calvert City site, the new unit is expected to be on stream in early 1958 and will have a capacity of several million pounds of glacial acrylic acid per year. Availability of the glacial product on this scale will offer important handling advantages to manufacturers now using water solutions of acrylic acid.

The new plant will be integrated for the production of acrylic resins as well as the acid.

The acrylic plant is the third unit of the B. F. Goodrich Chemical Co. development in Calvert City. The first unit, a vinyl chloride monomer operation, opened in early 1953. This was followed by the acrylonitrile plant, which started production in 1955.

**Bahrain Petroleum Co., Ltd.,** has placed the first combination UOP Platforming-Unifining unit in the Middle East on stream, producing 211,000 bpd.

Design capacity of the new unit is 11,000 bpsd with the Unifining section serving as a pretreater for the Platformer. The unit is set for an alternate operation—processing either 30 per cent cracked naphtha and 70

## Who's Building . . .

per cent straight run naphtha or only straight run naphtha which boils in the range of 195-340°F. The platformer is designed to produce a high octane blending component.

**El Paso Gas Products Co.** has placed its new Ciniza refinery on stream 18 miles east of Gallup, N. M., and is producing high-octane gasoline. The new facility has a capacity of 8000 barrels of crude oil daily. It is the first refinery to be constructed by the company and is owned by the El Paso Natural Gas Co. Crude oil is drawn from a gathering network spread through the San Juan Basin.

**Universal Oil Products Co.** is constructing a plant for the production of an important aviation gasoline blending component at its Stanlow refinery. The new udex unit, costing 800,000 pounds, is expected to go on stream in mid-1958. It will use as feedstock the products from a nearby platformer unit completed in 1953. The plant will have six columns, the two tallest being 120 feet and 77 feet respectively. The udex unit will be of the solvent extraction type, using special solvent mixture.

**The Borden Co.** plans to add two new units in Brazil; a 40 million gallon-per-year methanol plant, to go on stream in January, and an additional formaldehyde plant, ready for startup. This will bring the company's Brazilian capacity for that product to 60 million pounds per year.

**Universal Oil Products Co.** has put an 8,000-bpsd platforming unit on stream at the refinery of Salt Lake Refining Co. Designed to produce a high octane blending component, the unit is processing a straight run naphtha in the 200 to 400 F. boiling range.

**Sinclair Chemical Co., Inc.,** has begun construction of a new plant for the manufacture of paraxylene at Houston.

The new facility which will have an initial yearly capacity in excess of 50 million pounds of paraxylene will be integrated into the refining units of Sinclair Refining Co. at Houston and is scheduled to be in operation the first quarter of 1959. The Houston unit will also produce about 60 million gallons annually of pure toluene and mixed xylenes for sale to the chemical industry and for producing high octane gasolines.

**Southern Union Gas Co.** plans to build a gasoline plant in Rio Arriba County, N. M. The $813,000 plant will have a rated capacity of 65 MMcf per day Pona Engineers, Inc., will do the construction beginning in early spring, with completion slated for September, 1958.

**Universal Oil Products Co.** has begun work on a new plant for the production of an aviation gasoline blending component at Stanlow refinery, Cheshire. The new udex unit will cost $2.2 million and will go on stream in mid-1958.

**Imperial Oil Co., Ltd.,** plans to spend about $2.5 million on expansion of their Vancouver, B. C., refinery. Capacity of the plant will be increased 7,300 bpd through


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## Who's Building...

addition of an atmospheric furnace. Storage tanks, drying facilities, a stove-oil treater, and a new depropanizer will be included. Canadian Bechtel has the main contract.

**A/S Esso Raffineriet (Norway)** will build a new refinery at Slagenstangen a Naesa, on the western side of Oslo Fjord, near Tonsberg.

**Compania Shell de Venezuela** has built a new catalytic cracker and alkylation plant, each the first of its kind to be built in Venezuela. The units were commisioned recently at the Cardon refinery on the Paraguana peninsula. The cracker has a capacity of 33,000 bpd, and the alkylation plant an initial design capacity of 1,400 bpd. Also under construction at the refinery is a fourth distillation unit which will raise Cardon's total capacity to about 300,000 bpd. Total cost of the three plants will be almost $92 million.

**Socony-Mobil Oil Co.** has received from the Greek government a ten-year lease on its new 27,000 bpd refinery at Aspropyrgos. The award is the result of bidding in which nine companies or groups made offers. Socony said that the refinery is expected to supply most of the requirements of all major products in Greece except aviaiton gasoline and lubricants, which it will not manufacture.

**The Caltex Petroleum Maatschappij N.V.** plans to double capacity at its Pernis refinery. Early in 1960 it will be able to process 5.5 million tons per year. The construction will incude a crude oil distillation unit and a second platformer for the manufacture of high octane and low-sulfur gasoline. Storage capacity for crude oil and for products will be increased, and jetties, workshops, etc., will be enlarged. The company will acquire a 247-acre site in the Boltek area for oil storage.

**Humble Oil & Refining Co.** is expanding its p-xylene unit at Baytown, Texas, to bring capacity to 66 million pounds per year. Present capacity is 44 million pounds per year. Chief users of p-exylene are synthetic fibers like orlon and dacron.

**Commerce Oil Refining Co.** plans to start work on Rhole Island's first big oil refinery at Jamestown, R. I., in April or May. Completion is expected in June, 1959.

Engineering on the refinery has already been completed and ground cleared for the project. The plant will handle about 40,000 bpd and will be located on deep water. Cost will be $55 million, output will be chiefly 100 octane gasoline to be marketed in New England.

**British Hydrocarbon Chemicals Co.,** a company jointly owned by **The Distillers Co.** and **British Petroleum Co.,** will build a new plant for the synthesis of phenol from cumene at Grangemouth, Stirlingshire. The plant will use cumene made at Grangemouth from benzene and propylene, a product of existing cracking units. Acetone will also be obtained from the conversion of cumene to phenol. The plant will be completed in mid-1959 at a cost of $22 million which will include a high density poleythylene installation also being built at Grangemouth.

**Asia Oil Co.'s** Yokahoma refinery has placed Japan's first combination UOP Platforming-Unifining unit on stream there.

The unit has a design capacity of 1,500 bpsd. The Unifining section serves as a pretreater for the Platforming operation and is processing naptha derived from Middle East crudes. The Platformer, designed to produce a 90 clear octane blending component, is the first catalytic reforming unit in this country producing reformate of this octane quality.

Universal Oil Products Co., Des Plaines, Ill., designed and engineered the combination unit and licensed it through Japan Gasoline Co., Ltd., UOP's licensing agent in Japan. Japan Gasoline Company did the detailed design and construction.

**Shell Pernis Chemische Fabrieken N.V.** plans a synthetic rubber plant with an initial capacity of 50,000 tons per year. The plant will be constructed at Pernis, near Rotterdam.

**Vickers Petroleum Co., Inc.** has a new Vickers Chemical division. It will operate in conjunction with the $2.5 million Udex aromatics-extraction unit being built by Vickers at its Potwin, Kan., refinery. The new division will sell and distribute benzene, toluene, xylene, and other aromatic solvents from the Udex unit.

**Hercules Powder Co.** has postponed indefinitely its plans to build an $11 million methyl-methacrylate plant at Louisiana, Mo. The project was to be undertaken jointly with Imperial Chemicals, Ltd., of England, and was to operate as Hawthorne Chemical Co.

**Gulf Oil Corp** has signed an agreement with Philippine Investment-Management Consultants, Inc. which, subject to approval by the Philippine government, will form a petroleum refining and marketing company in the Philippines. No name as yet has been decided upon for the new company, in which the majority ownership will be held by Philippine interests.

If the proposal is approved, a 10,000-bpd refinery will be built on the Island of Luzon. Estimated completion date of the proposed refinery is late 1960 or early 1961. Gulf will furnish the crude oil. The new company will market petroleum products in the Philippines.

The proposed refining and marketing company will be the first controlled and operated by Philippine interests.

**Ominium Francaise des Petroles** will build the first refinery to take advantage of the proposed Marseille-Rotterdam pipe line system. The company expects to have a 60,000-barrel plant on stream by 1961 at Chalon-sur-Saone. It will take feed from a 260-mile line running north from Marseille.

The private company is owned by the old Suez Canal Co. and the Banque de

Paris and is a partner of Phillips Petroleum Co. in bids for concessions in Algeria, where Ominium plans to develop supplies for the refinery.

**The Smiley Gas Conservation Plant** has its new $750,000 gas processing plant about to start operation. The plant, owned by four different corporations, will process 300 MMcf per day. It is located in the Smiley area of Saskatchewan. Residue gas is to be sold to Saskatchewan Power Corp.

**ANCAP, the Uruguaian government owned oil company** is now building a refinery at Montevideo. The refinery's crude distillation unit will have a capacity of 28,000-pbd. The M. W. Kellog Co. has the engineering-construction contract and the project should go on stream in late 1959. The plant will cost $12 million.

**California-Texas Oil Co.** has placed on stream a new Universal Oil Products designed fluid catalytic cracking unit at Caltex S.A.F., French affiliate of the company. The unit is rated at 5,150 bpd with a coke burning capacity of 4,500 pounds per hour, and will process Middle East crudes.

**W. R. Grace Co.** is planning a 20,000 ton Urea expansion at Memphis. This will bring capacity there to 75,000 tons yearly. The program includes modifying the present plant and installation of new equipment. Foster Wheeler Corp. will handle the construction.

**Tidewater Oil Co.** plans to build a new 22,500-bpd houdriformer this month at the company's Avon, Calif., refinery. The unit has been designed to double existing capacity. Plans were also announced that a coke-burning boiler will be built next year, designed to burn 170,000 tons per year. Coke will be supplied by a 42,000-bpd fluid coking unit built last year at Avon.

**Standard Oil Co. of California** plans to build a 10,000 bpd catalytic reformer at its Perth Amboy, N. J., refinery. H. K. Ferguson Co. will do the construction, with completion slated for early in 1959.

**Jefferson Chemical Co.** plans to put its new 60 million pound per year ethyleane oxide plant at Port Neches, Texas, into operation in 1958. Scientific Design Co. will do the building.

**Standard Oil Co. (Indiana)** will have a new 140,000 bpd crude still at its Whiting, Ind., refinery in 1959. The new unit will permit abandoning several smaller units in use for many years.

**Monsanto Chemical Co. and Carbometal S.A.I.C.** plans a new plant at Mendoza, Argentina, to manufacture vinyl chloride monomer and polyvinyl chloride.

**Amoco Chemicals Corp.** plans to construct an Oxo alcohol plant with an annual capacity of 50 million pounds. The plant will probably be on company-owned land on the Gulf Coast or in the Midwest.

**Celanese Corp.** of America has begun manufacturing trimethylolpropane at a new production unit in its Bishop, Texas, plant.

Prior to coming on stream with this unit, which has a capacity in excess of 10 million pounds a year, Celanese had been supplying users with the output of a large-scale semiworks unit at Bishop for 18 months. This unit is said to be unusually flexible and can be used for production (in addition to trimethylolpropane) of anhydro enneaheptitol, trimethylolethane, neopentylglycol and other aldol products.

Trimethylolpropane is an organic chemical intermediate whose principal use is in the production of polyurethane foam.

**Monsanto Chemical Co.** is now building a 100 ton-per-day urea plant at El Dorado, Ark., scheduled to go into production by early fall. The plant will make urea in both prill and solution forms.

**Cities Service Oil Co.** has started construction on a $27 million refinery in Trafilgar Township, near Toronto, Canada. The project, to be completed in 1959, will receive crude oil through the Interprovincial pipe line. Products will be distributed in Southern Ontario and Western Quebec.

**Transcontinental Gas Pipe Line Corp.** is building a $2 million unit in McCullen County, Texas, to remove water and acid from gas before it is piped to consumers. Fluor Corp. is doing the construction.

**E. I. duPont de Nemours & Co.** plans to build its second plant for manufacturing methylterephthalate (DMT), an essential ingredient for making "Dacron" polyester fiber. The new plant will be in Old Hickory, Tenn., where it will adjoin other units of the company at that location. Completion is slated for 1959.

**Petroleos Mexicanos.** The Mexican controlled oil company, plans to build a large gas processing plant in the state of Tebasco. The plant will process 300 MMcf per day and will reinject the dry gas into the field formation.

The plants will cost about $12 million.

**Friesia Oil Co.** has announced plans to construct a $17 million refinery in West Germany. The Ralph M. Parsons Co. will construct the refinery and operate it for the first 18 months, assuming any loss should the refinery fail to produce at a pre-determined cost level. Construction will begin in March.

**International Synthetic Rubber Co.** has carried out the design and procurement contract for a 50,000 ton-per-year synthetic rubber plant at Hythe. Matthew Hall & Co., Ltd., will be subcontractors to the Blaw-Knox Co. on the project. Construction of the main plant has been started.

**La Cia Espanola de Petroleos** has been granted permission to build a plant in the Canaries for petrochemical production. Plant capacity will be 110,000 tons of ammonium sulphate.

## Who's Building . . .

**The Pure Oil Co.** has begun an addition to its Adena field gasoline plant in Colorado. A new compressor is now being installed and two more will be added in the next 30 days. The increased facilities are expected to raise capacity by MMcf per day.

**Anderson-Pritchard Oil Corp.** will build an HF alkylation unit at its Arkansas City, Kan., refinery. The unit will produce nearly 2,500 bpd of finished motor alkylate from a mixed stream charge of propylene and butylene. The Refinery Engineering Co. will engineer and construct the unit.

**W. R. Grace and Co.** is upping its annual capacity at Memphis by 20,000 tons. Expanded capacity there will be 75,000 tons yearly, the result of modifying the present plant and putting in new equipment. Foster Wheeler Corp. is doing the work.

**British American Oil Co., Ltd.,** will build a $4 million catalytic reforming unit at its Moose Jaw, Saskatchewan, refinery. Scheduled for completion in late 1958, the plant will produce 5,400 bpd. It will be the sixth such plant built by British American in three years.

**Transcontinental Gas Pipe Line Corp.** plans construction of a 75 MMcf-per-day gas treating and dehydration plant in McMullen County, Texas. The installation will remove acid and water from the gas. Construction will be by Fluor Corp., Ltd., and will cost over $2 million.

**North Star Oil, Ltd.** plans construction of a catalytic reforming unit at its new 11,000 bpd refinery at St. Boniface, Manitoba. Contracts for the $1.5 million unit have not yet been awarded.

**Esso Standard Oil Co.** will build a new plant in Trieste, Italy for producing high octane fuels. Plant construction and equipment fabrication will be by Compagnia Tecnica Italiana Petrolio.

**The Carter Oil Co.** is raising capacity at its Billings, Mont., refinery from 25,000 bpd to 34,000 bpd crude by modifying existing equipment. The program will cost about $1.5 million.

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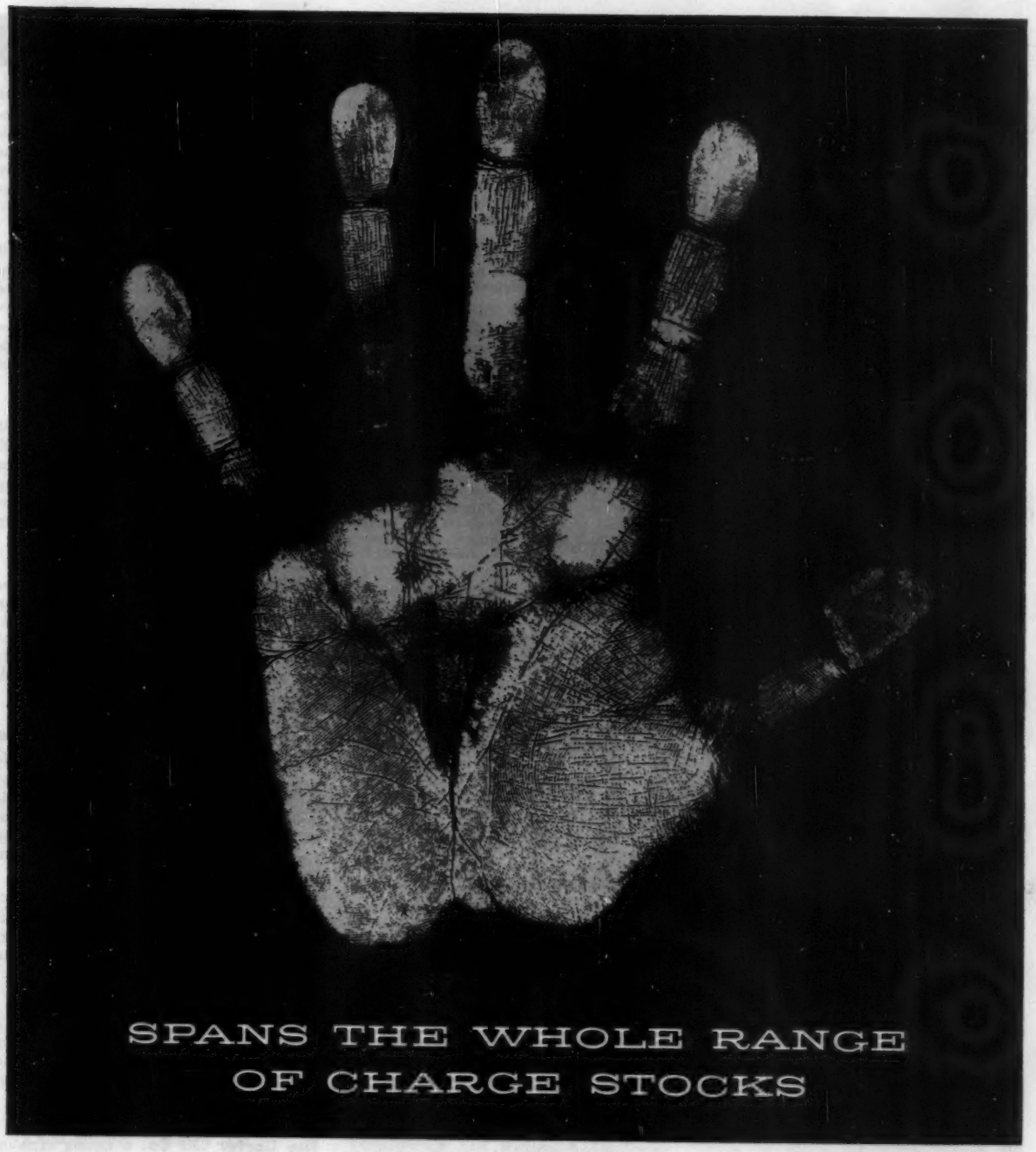


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# Millions Going for Product Quality

**Actual growth of the refining industry is slowing as refiners spend more and more of their construction dollars for higher octanes and better treating.**

**Clayton A. Umbach, Jr.**
Petroleum Refiner Staff

LAST YEAR showed us the overall growth of the U. S. refining industry is slowing down. In March, 1957, the crude running capacity in the U. S. stood at 8,940,000 bpcd. By mid-1958 this amount will have only increased to 9,207,000 bpcd, and in the same period of 1959, it will be up just another 236,000 bpcd.

Even though there was a slight increase last year in crude running capacity, bulging inventories forced refiners to actually cut runs by 3.3 million barrels (9,000 bpd) from the previous year. In spite of this cut refiners still started 1958 with product stocks totaling 534.6 million barrels—up nearly 41 million barrels (112,000 bpd) over a like period in 1956.

This doesn't mean, however, refiners have stopped construction entirely. Far from it. They are still pouring millions of dollars into units which upgrade the quality of the gasoline. Of course, there are still new units being built which will increase crude capacity, but for the most part they will replace their older counterparts which have become outdated by rapid technological advances.

Here's a rundown on the refining dollar—where it went and where it will continue to go for the next couple of years. All data reported herein are from a recent report of The National Petroleum Council. The report considers capacities on a calendar-day basis, with allowance for normal downtime for inspection, cleanout and repairs. This includes capacity that is shutdown but in operable con-

**CHARGING CAPACITY OF U. S. REFINERIES[1]**

| Process Type | Thousand BPCD (Percent of Crude in Parenthesis) | | |
|---|---|---|---|
| | 3-31-57 | Mid 1958 | Mid 1959 |
| Crude Distillation | 8,940 (100.0) | 9,207 (100.0) | 9,443 (100.0) |
| Thermal Processes (Fresh Feed): | | | |
| Reforming | 278 (3.1) | 216 (2.3) | 209 (2.2) |
| Gas Oil Cracking[2] | 610 (6.8) | 622 (6.8) | 600 (6.4) |
| Residuum Cracking | 826 (9.2) | 816 (8.9) | 847 (9.0) |
| Coking | 418 (4.7) | 420 (4.6) | 448 (4.7) |
| Catalytic Cracking: | | | |
| Fresh Feed | 2,993 (33.5) | 3,089 (33.6) | 3,283 (34.8) |
| Total Feed | 3,871 (43.3) | 4,040 (43.9) | 4,320 (45.7) |
| Catalytic Reforming | 1,177 (13.2) | 1,649 (17.9) | 1,754 (18.6) |
| Hydrogen Treating: | | | |
| Cat Reformer Feed | 585 (6.5) | 1,009 (11.0) | 1,122 (11.9) |
| Other Feeds | 41 (0.5) | 90 (1.0) | 100 (1.1) |
| Product Treatment | 297 (3.3) | 404 (4.4) | 472 (5.0) |

[1] Data taken from a report of The National Petroleum Council, "United States Refining Capacity", 1958.
[2] Includes capacity which may undergo residuum cracking as alternative.

dition. For crude oil distillation, capacity is based on charging 100 percent crude oil and not on mixtures of crude oil and natural gasoline, distillates, etc.

These numbers are lower than those reported in the tabulated portion of Construction Boxscore, and from previous Boxscore articles. The difference lies in that operating companies and engineering-contractor firms report directly to Construction Boxscore in numbers which reflect design or stream per day capacity.

**Thermal (gas, oil and residium) Cracking** will find it difficult to hold its present share of crude running, and will probably decrease slightly. In March of last year these two processes accounted for 1,436,000 bpcd, or about 16 percent of charging capacity. By mid-1958, daily capacity will have risen to 1,438,000 barrels, but percentage wise it will have dropped to 15.7 percent. Then by mid-1959, capacity will have eased up to 1,447,000 bpd, but again the percent will have decreased to 15.4 percent.

**Catalytic cracking** will hold its own in the next two years, and may even inch-up slightly. Total cat cracking capacity in March, 1957 stood at 3,817,000 bpcd—43.3 percent of crude capacity. Building in this area will continue to climb slightly for the next year, and by mid-1959 should stand at about 4,320,000 bpd, or 45.7 percent of total thruput.

**Catalytic reforming** is one process which is grabbing a bigger and bigger bite of both the construction dollar and the crude running capacity. Refiners are betting that for the next few years, gasoline octanes will need to increase to keep up with Detroit's compression ratios. Not only that, but as more older cars are traded in for the high-powered jobs, we will need greater quantities of the super-premiums.

**The "Construction BOXSCORE" has been an exclusive presentation of Petroleum Refiner for the past 10 years. It represents a continuing check on the world wide building program of the Refining-Processing Industry. If any reader knows of any projects which are not listed, or sees any which need correcting, please send such information to Petroleum Refiner, BOXSCORE Editor, P. O. Box 2608, Houston 1, Texas, U.S.A.**

In March of last year, the catalytic reforming capacity stood at 1,177,000 bpcd, equivalent to 13.2 percent of crude charging capacity. By the middle of this year it will stand at 1,649,000 bpcd and by the same period in 1959, it will have skipped to 1,754,000 bpcd—18.6 percent of the crude capacity.

**Hydrogen treating** is in the same boat. Whereas in March, 1957, the total stood at 923,000 bpcd (10.3 percent), it will continue to increase and by mid-1959 should account for 1,694,000 bpcd (18 percent)—an increase of almost 80 percent. Of course, the one factor which contributes the most to this phenomenal rise is the contribution of this process to improve catalytic reformer feed.

From these figures we can clearly see that more and more construction dollars are being funneled into product quality units. If the trend continues, and if the refiners are called upon to squeeze higher and higher octanes from crude, it is certain that they will have to turn to even fancier techniques and units. If this is the case, we will see more of the independents with small refineries either closing entirely or else merging with the majors. The little fellow just can't afford these high-powered processes.

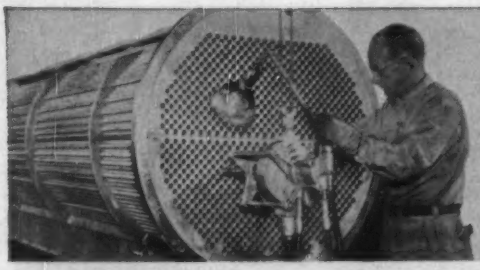
# Construction BOXSCORE

## REFINERIES, NATURAL GASOLINE AND PETROCHEMICAL PLANTS

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| **EAST** | | | | | | | | | |
| Allied Chemical & Dye | Buffalo, N.Y. | Polyethylene | ..... | ..... | ..... | Mid 1958 | ..... | ..... | ..... |
| American Oil Co..... | Yorktown, Va. | Gas Treating Sulphur Recovery | 80 tons | ..... | Complete | ..... | ..... | Fluor | Fluor |
| California Oil Co..... | Perth Amboy, N.J. | Splitting Tower & Offsite Facilities | ..... | ..... | ..... | ..... | ..... | Foster Wheeler | ..... |
| | | Cat. Reformer | 10,000 bbls. | ..... | Under Constr. | 4th Qtr. 1958 | ..... | Ferguson | Ferguson |
| Chemstrand..... | Decatur, Ala. | Exp. Acrilan Plt. | 45,000,000 lbs./yr. | ..... | Under Constr. | 1958 | ..... | Staff | Daniel Constr. |
| | Pensacola | Exp. Nylon Plt. | 114,000,000 lbs./yr. | ..... | Under Constr. | 2nd Qtr., 1958 | ..... | Staff | ..... |
| Cities Service..... | Linden, N.J. | Refinery Modernization | ..... | ..... | Planning | 1958 | ..... | ..... | ..... |
| | | Asphalt Plt. | ..... | $8,000,000 | Under Constr. | 1958 | ..... | Braun | Braun |
| Columbia Hydrocarbon..... | Siloam, Ky. | Hydrocarbon Fractionation Plt. with pipe line and offsite facilities | 230,000,000 gal./yr. | $5,000,000 | Under Constr. | Dec. 1958 | ..... | Pritchard | Pritchard |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 235*



## CONDENSER AND HEAT EXCHANGER CLINIC

Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, N. Y.

# Duplex Tubes handle dual corrosion problems —or unusual pressure-temperature conditions

Anaconda Duplex Tubes are special-purpose products designed primarily to meet requirements involving dual problems of corrosion. They are usually made by drawing tubes of copper or a copper alloy either inside or outside of steel tubes. However, they can be furnished in any combination of components, including copper or copper alloys with other nonferrous metals or steel, in a wide range of diameters and wall thicknesses.

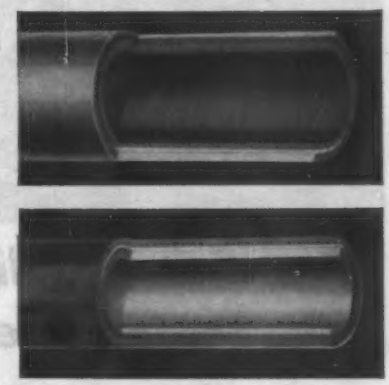
A Duplex Tube of steel with copper or a copper alloy inside is used, for example, in exchangers or condensers handling water in the tubes and ammonia or a fluid with appreciable amounts of ammonia in the shell. Moist ammonia attacks copper and all of its alloys, and may cause stress-corrosion cracking. Steel, however, is not susceptible to such action by ammonia. Thus, the nonferrous tube is shielded and can perform its normal function of giving long service life and efficient heat transfer on the "water side."

Other combinations of coolant—or heating fluid—and "stream" are found in petroleum refineries and chemical plants, in which differing properties are required inside and outside an exchanger tube. Here, two nonferrous metals may be combined—a Cupro Nickel and Admiralty, for example.

**For extra strength.** Anaconda Duplex Tubes can also be used in those applications where internal or external pressures—or the pressure-temperature combinations—are too great for a nonferrous tube alone. In this case, the nonferrous tube is selected for the chemical properties required for the more corrosive fluid handled; and the steel tube gives the needed strength.

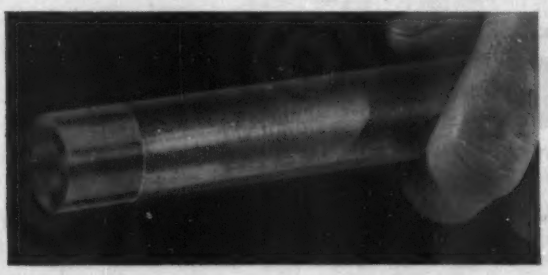
**Heat transfer properties.** The fabricating method by which Anaconda Duplex Tubes are manufactured assures a tight mechanical bond between the outer and inner components of the tube. This tight mechanical bond assures no significant loss of heat transfer across the interface between the two components of the duplex tube. With duplex tubes, copper and steel or copper alloy and steel, the heat transfer will be definitely superior to that of a solid steel tube of the same total wall thickness regardless of which metal is inside or outside.

**U-bends.** The compact U-bend tube design in heat exchangers has many advantages, particularly where wide temperature differences exist in the unit. And Duplex Tubes can be readily bent to form the hair-pin or U-bend tubes required—in the longer lengths now becoming increasingly popular.



**Duplex Tubes are made** by drawing copper or copper alloy tubes either inside or outside of steel tubes—or of tubes of a different copper alloy.

**Technical Assistance.** Specialists at The American Brass Company are constantly working with manufacturers and users of heat exchange equipment, helping to solve process problems. This experience is available to you. For more detailed information on Duplex Tubes, U-bend Tubes, address: The American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 8877



**Duplex Tubes can be furnished** with the outside tube cut back to be replaced by a ferrule of the same composition as the inside tube—to avoid galvanic corrosion.

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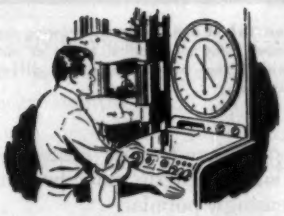

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## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Commerce Oil Ref.... | Jamestown, R.I. | Refinery, Cat. Cracking Crude Units | 40,000 bbls. 25,000 bbls. 40,000 bbls. | $50,000,000 | Under Constr. | Mid 1959 | UOP | Fluor | Fluor |
| du Pont..... | Belle Works, W. Va. | Urea; Ammonia Methyl Methacrylate, Nylon Intermediates | ..... | ..... | Planned | 1959 | Texaco | ..... | ..... |
| Escambia Chemical... | Pensacola, Fla. | Methanol | 18,000,000 gal./yr. | ..... | Complete | ..... | ..... | Chemico; Badger Mfg. | ..... |
| Esso Standard..... | Bayway, N.J. | Hydrofiner | 15,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| Food Machinery & Chemical Corp. | S. Charleston, W.Va. | Exp. Carbon Tetrachloride Plt. | ..... | ..... | Engineering | Mid 1958 | ..... | Staff, Fluor | Fluor |
| Frontier Refining..... | Buffalo, New York | Aromatics Plts. | 45,000 gal. | $2,500,000 and $1,250,000 offsite facilities | Complete | ..... | UOP | UOP | Procon |
| Gulf Oil..... | Near Charleston, S.C. | Refinery | ..... | ..... | Considering | ..... | ..... | ..... | ..... |
| Hercules Powder..... | Parlin, N.J. | Polyethylene | 30,000,000 lbs./yr. | $10,000,000 | Complete | ..... | ..... | ..... | ..... |
| Koppers..... | Woodbridge, N.J. | Polyethylene | 30,000,000 lbs./yr. | ..... | Under Constr. | ..... | Koppers | Koppers | Koppers |
| | Kobuta, Pa. | Polystyrene | ..... | ..... | Complete | ..... | ..... | Staff | Staff |
| Paragon Oil Co..... | Tiverton, R.I. | Refinery | 30,000 bbls. | $35,000,000 | Planning | ..... | ..... | ..... | ..... |
| Pennsalt..... | Calvert City, Ky. | Organic-Fluorine | ..... | ..... | Under Constr. | ..... | ..... | Staff | Miller & Johnson |
| Reichhold Chemicals.. | Hampton South Carolina | *Formaldehyde Plant | 30,000,000 lbs./yr. | ..... | Engineering | July, 1958 | ..... | ..... | ..... |
| Rhode Island Ref.... | Tiverton, R.I. | ..... | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Sinclair Refining..... | Marcus Hook, Pa. | Gasoline Fractionation | 10,000 bbls. | ..... | Under Constr. | ..... | ..... | Fluor | Fluor |
| Socony Mobil..... | Buffalo, N.Y. | Alkylation | 2,440 bbls. | ..... | Under Constr. | ..... | ..... | Kellogg | Kellogg |
| | Paulsboro, N.J. | Delayed Coker | 19,000 bbls. | ..... | Engineering | Early 1959 | ..... | ..... | Lummus |
| Spencer Chemical.... | Henderson, Ky. | Urea Plt. | 100 tons | ..... | Under Constr. | Summer 1958 | Montecatini | Staff | Quaker Valley |
| The Southland Co.... | Black Point, Fla. | Refinery | 15,000 bbls. | $12,000,000 | Planning | ..... | ..... | ..... | ..... |
| Sunshine States Refineries | East Tampa, Fla. | Refinery | 20,000 bbls. | $27,000,000 | Under Design | 1959 | ..... | Kaiser | Kaiser |
| Union Carbide Chemicals | Institute, W.V. | Exp. Acrylonitrile Plt. | ..... | ..... | ..... | 2nd Qtr., 1958 | ..... | ..... | ..... |
| | Winfield, W.V. | Petrochemical Plt. | ..... | ..... | Planning | 1960 | ..... | ..... | ..... |
| United Fuel Gas Co... | Kenova, W.V. | Hydrocarbon Extraction Plt. | ..... | $9,000,000 | Engineering | Dec., 1958 | ..... | Pritchard | Pritchard |
| **MID-CONTINENT** | | | | | | | | | |
| Amoco Chemical Corp. | Joliet, Ill. | Phthalic Anhydride Isophthalic Acid, Terephthalic Acid, Diemthyl Terephthalate, Dimethyl Isophthalate Benzoic Acid | 60,000,000 lbs./yr. | $10,000,000 | Under Constr. | Oct. 1958 | ..... | Scientific Design | S. D. Plants |
| Anderson-Prichard.... | Arkansas City, Kans. | H. F. Alkylation Unit | 2,250 bbls. | ..... | Under Constr. | Oct. 1958 | UOP | UOP; Treco | Treco |
| Bay Refining Corp.... | Bay City, Mich. | Crude Unit | 12,000 bbls. | $900,000 | Engineering | Summer 1958 | ..... | Sweco | Sweco |
| Callery Chemical..... | Muskogee, Okla.. | Hydrogen Plt. | 800,000 scf | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Nitrogen Plt. | 200,000 scf | ..... | Under Constr. | Aug., 1958 | ..... | Girdler | Girdler |
| | | Carbon Dioxide | 7,790 lbs./hr. | ..... | ..... | ..... | ..... | ..... | ..... |
| Champlin Oil & Ref... | Enid, Okla. | HF Alky Unit | 1,430 bbls. | $1,900,000 | Complete | ..... | Phillips | Badger Mfg. | Badger Mfg. |
| Cities Service..... | East Chicago, Indiana | *Cat Reformer | 7,500 bbls. | $4,000,000 | Under Constr. | Late 1958 | UOP | Staff Procon | Procon |
| Clark Oil & Ref..... | Chicago | Refinery Expansion | 9,000 bbls. | $5,000,000 | Under Constr. | ..... | ..... | ..... | ..... |
| | | Vacuum Unit | ..... | ..... | Under Constr. | ..... | ..... | UOP | CB&I; Morrison |
| | | Alkylation | ..... | ..... | Under Constr. | ..... | UOP | Dushell | Morrison |
| | | Gas Recovery | ..... | ..... | Under Constr. | ..... | UOP | UOP; Procon | Procon |
| | | Cat Cracker | ..... | ..... | Under Constr. | ..... | UOP | UOP; Procon | Procon |
| Coastal Chemical Corp. | Pascagoula, Miss. | *Ammonia | 150 tons | $6,250,000 | Under Constr. | Feb., 1959 | ..... | Staff | Staff |
| Cooperative Refinery Asso. | Phillipsburg, Kans. | Unifiner | 3,500 bbls. | $1,500,000 | Complete | ..... | UOP | Sweco | Sweco |
| | | Platformer | 2,500 bbls. | | | | | | |
| | Coffeyville, Kans. | HF Alkylation Unit | 1,100 bbls. | $1,500,000 | Under Constr. | Summer, 1958 | UOP | Treco | Treco |
| Dow Chemical..... | Bay City, Mich.. | Ethylene Plt. | ..... | ..... | Under Constr. | 1959 | ..... | ..... | ..... |
| | | Gas Purification | ..... | ..... | Under Constr. | ..... | ..... | Girdler | Austin |
| du Pont..... | Ecorse, Mich. | Sulfuric Acid Plt. | ..... | ..... | Under Constr. | ..... | ..... | Staff | Staff |
| D-X Sunray..... | Duncan, Okla. | Unifining | 6,000 bbls. | $800,000 | Complete | ..... | UOP | Treco | Treco |
| | Tulsa | Unifining | 20,000 bbls. | | | | | | |
| | | HF Alkylation | 2,500 bbls. | $10,000,000 | Complete | ..... | UOP | Treco | Treco |
| | | Butane-isomerization | 2,500 bbls. | | | | | | |
| | | Platformer, Rerun Tower & LPG Recovery Unit | 12,000 bbls. | | | | | | |
| Ethyl Corp..... | Joliet, Ill. | Antiknock Compounds | ..... | ..... | Planned | ..... | ..... | ..... | ..... |
| Grace Chemical Div. W. R. Grace & Co. | Memphis, Tenn | *Ure Expansion | 300 tons | ..... | Under Constr. | March, 1959 | ..... | Foster Wheeler | Process Contracting Co. |
| Grand River Chem.. | Pryor, Okla. | *Ammonia | 10-15 tons | ..... | ..... | ..... | ..... | Treco | Treco |
| Gulf Oil..... | Toledo | *Alkylation Unit | 2,000 bbls. | ..... | Engineering | Feb., 1959 | ..... | Kellogg | Kellogg |
| Hawthorne Chemical Co. | Louisiana, Mo. | Methacrylate Plt. | 35,000,000 lbs./yr. | $11,000,000 | Postponed | ..... | ..... | ..... | ..... |
| Kerr McGee..... | Wynnewood, Okla. | Platformer | 5,500 bbls. | $4,500,000 | Under Constr. | Spring 1958 | UOP | UOP, Nofsinger | Treco |
| | | Dist. Unifiner | 4,000 bbls. | | | | | | |
| Leonard Refineries.... | Alma, Mich. | FCC Unit | 7,500 bbls. | $3,000,000 | Under Constr. | July, 1958 | UOP | Parsons | Parsons |
| | | Alkylation Unit | 1,000 bbls. | $1,100,000 | Under Constr. | Aug., 1958 | UOP | Parsons | Parsons |
| Lion Oil, Div. of Monsanto | El Dorado, Ark. | Unifiner—Platformer | 5,000 bbls. | $1,600,000 | Engineering | Late 1958 | UOP | UOP Procon | Procon |
| Mississippi Chemical Corp. | Yazoo City, Miss. | Add Nitric Acid Plt. | 150 tons | $1,500,000 | Complete | ..... | ..... | C & I | C & I |
| Monsanto Chemical.. | Monsanto, Ill. | Phenol Plt. Exp. | 25 percent | ..... | ..... | ..... | ..... | ..... | ..... |
| | El Dorado, Ark. | Urea Plt. | ..... | ..... | ..... | Fall 1958 | ..... | ..... | ..... |
| Nat'l Coop Refinery.. | McPerson, Kan. | *Revamp crude, coking, and alkylation units offsite Facilities | ..... | ..... | ..... | ..... | ..... | ..... | Treco |
| National Petro-Chemical | Tuscola, Ill. | Polyethylene Compounding | 25,000,000 lbs./yr. | $185,000 | Under Constr. | Summer 1958 | ..... | Procon | Procon |
| Northwestern Ref. Co. | St. Paul Park, Minn. | Cat. Reformer | 6,000 bbls. | $2,500,000 | Planning | Jan., 1959 | ..... | ..... | ..... |
| Olin Mathieson..... | Mapleton, Ill. | Antifreeze Plt. | ..... | $1,500,000 | Under Constr. | Spring, 1958 | ..... | ..... | P. S. Edwards Company |
| Pana Refining..... | Pana, Ill. | Platformer Unifiner | 1,870 bbls. | $1,000,000 | Under Constr. | 3rd Qtr., 1958 | UOP | Procon | Procon |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 236*

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Petroleum Specialties | Flat Rock, Mich | Visbreaker | 3,000 bbls. | $250,000 | Planning | ..... | ..... | Litwin | ..... |
| Phillips Petroleum | Kansas City, Kans. | Asphalt Exp. | 1,100 bbls. | ..... | Under Constr. | Spring 1958 | ..... | Staff | ..... |
| Preston Oil Co. | Siloam, Ky. | Hydrocarbon Fractionation & Storage Plt. | ..... | $1,714,000 | Under Constr. | Dec., 1958 | ..... | Pritchard | Pritchard |
| Prime Oil Co. | Calumet City, Ill. | Refinery | 15,000 bbls. | $10,000,000 | Planned | ..... | ..... | ..... | ..... |
| The Pure Oil Co. | Lemont, Ill. | Feed Prep. Unit | 17,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Odorless Naphtha | ..... | ..... | Complete | ..... | ..... | Staff | Tellepsen |
| | | Revamp Gas Recovery Unit | ..... | ..... | Complete | ..... | ..... | Staff | Tellepsen |
| | | Polymerisation Unit | ..... | ..... | Complete | ..... | ..... | Staff | Tellepsen |
| | | Revamp Crude Distill. | ..... | ..... | Complete | ..... | ..... | Staff | Tellepsen |
| | | Revamp Girbitol Unit | ..... | ..... | Complete | ..... | ..... | Staff | Tellepsen |
| Reichhold Chemicals | Tuscaloosa | Formaldehyde Plt. | 35,000,000 lbs./yr. | ..... | Planning | ..... | Staff | Staff | Staff |
| | Detroit | Formaldehyde Plt. | 35,000,000 lbs./yr. | ..... | Planning | ..... | Staff | Staff | Staff |
| Signal Oil & Gas | Healdton, Okla. | Absorption | ..... | $250,000 | Complete | ..... | ..... | Hudson | Hudson |
| | Tioga, N.D. | Absorption | ..... | $200,000 | Complete | ..... | ..... | Hammond Tank | Hammond Tank |
| Sinclair Oil & Gas | Garfield City, Okla. | Deisobutaniser | 20,000 gals. | ..... | Complete | ..... | ..... | ..... | ..... |
| Sinclair Refining | East Chicago | MEK Deoiling | 1,000 bbls. | ..... | Engineering | Fall 1958 | Texaco | Badger Mfg. | Badger Mfg. |
| | | Gaso. Fractionation | 18,000 bbls. | ..... | Under Constr. | 1958 | ..... | Fluor | Fluor |
| Skelly Oil Co. | El Dorado, Kan. | HF Alkylation | 3,000 to 4,000 bbls. | ..... | Engineering | 1958 | Phillips | Staff | Staff |
| | Medicine Lodge, Kans. | Exp. Natural Gaso. Plt. | 40,000 gals. | ..... | Complete | ..... | ..... | Staff | ..... |
| Socony Mobil | East St. Louis | Sovaformer | 12,000 bbls. | ..... | Planning | ..... | ..... | Fluor | Fluor |
| | | Pretreater | 16,000 bbls. | ..... | Planning | ..... | ..... | Fluor | Fluor |
| | Trenton, Mich. | Alkylation Unit | 3,500 bbls. | $3,500,000 | Engineering | 1958 | ..... | Fluor | Fluor |
| Standard-Indiana | Whiting, Ind. | Crude Distillation | 140,000 bbls. | ..... | Engineering | 1959 | ..... | ..... | McKee |
| | | Ultraformer III | 21,000 bbls. | ..... | Under Constr. | Mid 1958 | Std. (Ind.) | ..... | McKee |
| | Neodesha, Kans. | Ultraformer | 6,000 bbls. | ..... | Under Constr. | 1958 | Std. (Ind.) | Foster Wheeler | Foster Wheeler |
| | Wood River, Ill. | Crude Unit | 67,500 bbls. | ..... | Under Constr. | 1959 | ..... | ..... | McKee |
| | | *Cat Cracker | 30,000 bbls. | ..... | Under Constr. | Early 1959 | ..... | ..... | Foster Wheeler |
| | Mandan, N.D. | HF Alkylation Unit | 1,630 bbls. | ..... | Under Constr. | Sept., 1958 | Phillips | Foster Wheeler | Foster Wheeler |
| Standard (Ohio) | Toledo, Ohio | Refinery Exp. | †60,000 bbls. | $40,000,000 | Under Constr. | June, 1958 | ..... | Kellogg | Kellogg |
| | Cleveland, Ohio | Alkylation | 3,000 bbls. | $3,400,000 | Under Constr. | May, 1958 | Esso | McKee | McKee Co. |
| Sun Oil Co. | Toledo | Alkylation Plt. Exp. | ..... | $1,000,000 | Under Constr. | ..... | ..... | Staff | Catalytic |
| Union Carbide | Marietta, Ohio | *Liquid epoxy resin | 15,000,000 lbs./yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| Vickers Petroleum | Potwin, Kans. | Udex Unit | 15,000,000 gal./yr. | $2,000,000 | Under Constr. | 2nd Qtr., 1958 | UOP | Procon | Procon |
| Warren Petroleum & Sunray | Forgan, Okla | Gasoline Plt. | 100 Mmscf | $3,000,000 | Planning | Aug., 1958 | ..... | ..... | ..... |
| Westland Oil Co. | Williston, N.D. | Inc. Platformer | 530 bbls. | $320,000 | Complete | ..... | UOP | UOP | C. E. Wilson Constr. Co. |
| Witco Chemical | Chicago | *Phthalic Anhydride | 20,000,000 lbs./yr. | ..... | Engineering | Early 1959 | Scientific Design | Scientific Design | Scientific Design |
| Wyandotte Chem. | Wyandotte, Mich. | *Propylene Oxide | ..... | ..... | Under Constr. | 2nd Qtr. ,1958 | ..... | Staff | Staff |
| **SOUTHWEST** | | | | | | | | | |
| American Cyanamid | Fortier, La. | Acrylonitrile Plt. | 100,000,000 lbs./yr. | $25,000,000 | Under Constr. | 1958 | ..... | ..... | ..... |
| American Oil | Texas City | Ultraformer & Desulfurization Unit | 21,000 bbls. | ..... | Engineering | 1958 | ..... | Parsons | Parsons |
| | | Heating Oil System | ..... | ..... | Engineering | 1958 | ..... | Tellepsen | Tellepsen |
| | | Two Stage Distill Unit | ..... | ..... | Under Constr. | 1958 | ..... | Staff | Tellepsen |
| | | *Platformer | 3,000 bbls. | $800,000 | Under Constr. | Nov., 1958 | UOP | Pritchard | Pritchard |
| American Petrofina of Texas | Mt. Pleasant, Texas | | | | | | | | |
| Atlantic Refining | Pt. Arthur, Texas | Alkylation Unit | 2,100 bbls. | ..... | Under Constr. | Spring, 1958 | ..... | Fluor | Fluor |
| Atlas Processing | Shreveport, La. | Isomerization Unit | 3,500 bbls. | ..... | Under Constr. | 1958 | UOP | UOP | Hudson |
| Calcasieu Chemical | Lake Charles | Ethylene Oxide; Ethylene Glycol | 8,000,000 gal./yr. | ..... | ..... | 1958 | Shell | ..... | Lummus |
| Carbide & Carbon | Seadrift, Texas | Ethylene Oxide Exp. | To 200,000,000 lbs./yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| | | Inc. Ethylene Glycol Cap. | To 65,000,000 lbs./yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| Chemoil Corp. | New Orleans | Refinery | 40,000 bbls. | $35,000,000 | Design | ..... | ..... | Lummus | Lummus |
| Cities Service | Lake Charles, La. | Inc. Reforming Cap. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| | | Ethylene Plt. | 2,000,000 lbs./yr. | ..... | ..... | ..... | ..... | ..... | ..... |
| [illegible] | | Butane Isomerization | ..... | ..... | Under Constr. | 1958 | ..... | Tellepsen | Tellepsen |
| [illegible] | Dora Roberts Ranch, Texas | Natural Gaso. Plt. | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Continental Oil | Wichita Falls, Texas | Cat. Reformer | 3,500 bbls. | $1,450,000 | Complete | ..... | ..... | Treco | Treco |
| Copolymer Rubber & Chemical | Baton Rouge | Plt. Exp. Butadiene | 35,000 short tons/yr. | ..... | Complete | ..... | ..... | ..... | ..... |
| Cosden Petroleum | Big Spring, Texas | Polystyrene Plt. | 60,000 lbs. | $2,100,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Cotton Valley Operators | Cotton Valley, La. | Ethylene Recovery Unit | ..... | ..... | Complete | ..... | ..... | ..... | Delta |
| Diamond Alkali | Houston | Perchlorethylene Exp. | 50 percent | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | Acetylene Plt. | ..... | ..... | Engineering | ..... | ..... | ..... | ..... |
| | Deer Park | Vinyl Chloride Plt. | ..... | $10,000,000 | Engineering | 1958 | ..... | Scientific Design | Brown & Root |
| Dow Chemical | Plaquemine, La. | Ethylene and Propylene Glycols and Oxides, Chlorinated Solvents | ..... | Part of $50,000,000 | Under Constr. | 1958 | ..... | Bechtel; Sterns-Roger | Sterns-Roger; Tellepsen |
| | Freeport, Texas | Acetylene, Methylacetylene, Ethanolamines, Synthetic Glycerine, Butadiene, Chlorine, Ethylene Oxide, Methyl Chloride, Glycerine, Glycol, Perchloro Ethylene and Styrene | ..... | $45,000,000 | Under Constr. | 1958 | ..... | ..... | ..... |
| | | Glycerine Plt. | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| du Pont | Orange | Polyethylene | ..... | ..... | Under Constr. | 1958 | ..... | ..... | ..... |
| | Near New Orleans | Petrochemical Plt. | ..... | ..... | Considering | ..... | ..... | ..... | ..... |
| | Victoria, Texas | Crude Hydrogen | ..... | ..... | Complete | ..... | ..... | Girdler | Staff |

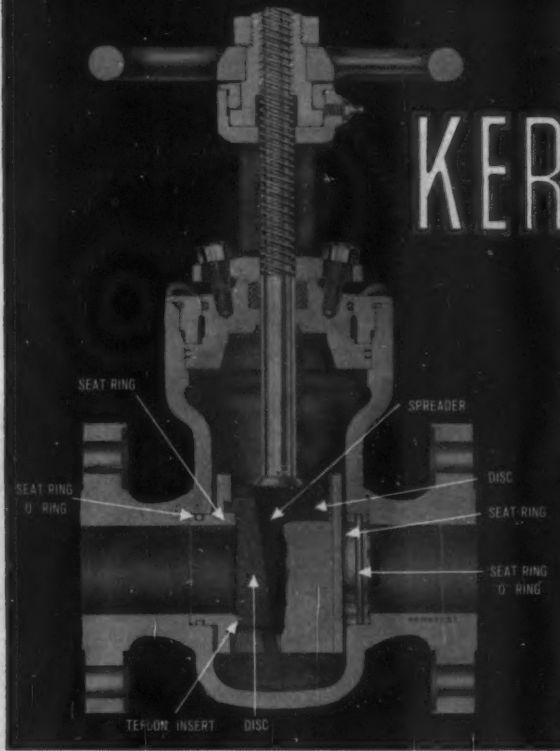
* First appearance in tabulation. † Added capacity.

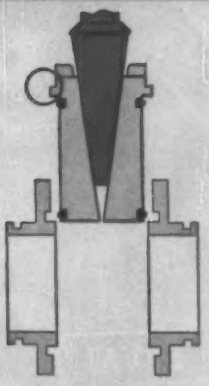
*Construction BOXSCORE Continued on Page 239*

# In Gas, Petroleum or Chemical Industries . . .

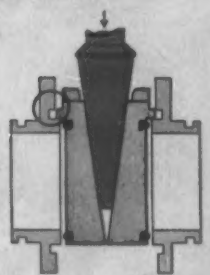
## Use the NEW

# KEROSEAL® VALVE

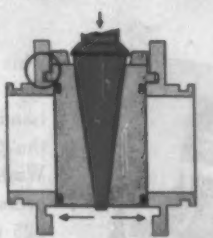


Valve fully open. In closing, discs and spreader move down, perpendicular to flow.



Discs are positioned without drag across seat. When disc lug rests on seat ring, continued downward motion of spreader moves discs parallel to flow.



Valve fully closed. Spreader holds discs vapor-tight against seat rings. When opening, seated discs are retracted with the same parallel motion—again with no drag against seating surfaces. The upward motion does not begin until discs are clear of seat ring.

## It's vapor-tight • non-lubricated • optional flow • full opening • double block and bleed

The new vapor-tight, non-lubricated Keroseal Valve offers a revolutionary concept in valve design, embodying advantages not found in any other valve. This Keroseal valve handles liquids and gases in the petroleum and petrochemical industry, as well as a wide variety of fluids in the chemical industry. A vapor-tight seal is effected mechanically without the use of costly lubricants. Wear, frictional drag, wiping and consequent galling of seating surfaces are eliminated by this entirely new principle of valve operation.

*For more information on the revolutionary Keroseal Valve, write today for your copy of this full-color bulletin.*

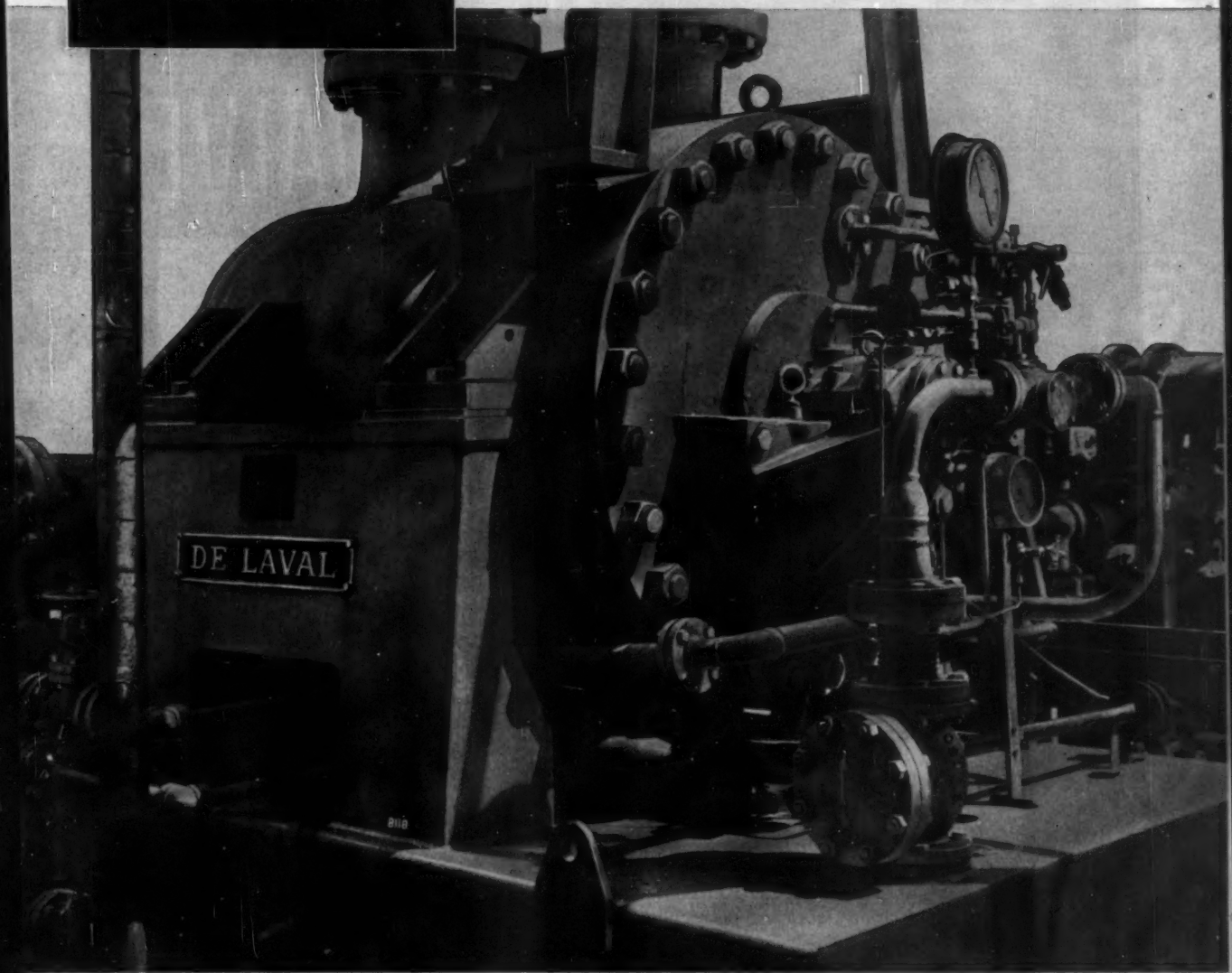
KEROTEST

**KEROTEST MANUFACTURING COMPANY**
**2514 Liberty Avenue, Pittsburgh 22, Pa.**
In Canada, Kerotest products are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario.

# DE LAVAL

**BARREL TYPE REFINERY COMPRESSOR**

## *handles hydrogen under high pressures in a reformer at General Petroleum*



*Send for new Bulletin 0504*

This De Laval centrifugal recycle barrel type compressor is doing a dependable job handling hydrogen under high pressures at the General Petroleum plant in Ferndale, Washington. It takes hydrogen at an inlet pressure of 500 psig and discharges it at 625 psig. The unit is driven by a 1110 hp turbine operating at 9900 rpm.

General Petroleum Corporation is only one of many refiners who have specified De Laval Compressors. Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval. Rugged De Laval centrifugal compressors perform dependably in heavy-duty continuous operation. De Laval has more than 40 years of experience in solving gas compression problems.

**DE LAVAL** *Centrifugal Compressors*

**DE LAVAL STEAM TURBINE COMPANY**

***811 Nottingham Way, Trenton 2, New York***

DL-587

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| El Paso Natural Gas Products | Odessa, Texas | Refinery | 6,500 bbls. | ..... | Complete | ..... | UOP | Fish | Fish |
| Esso Standard | Baton Rouge | Alkylation Blending | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | Ethylene, Butadiene Expan.; Wax, Lube Oil, Avgas | ..... | $40,000,000 | ..... | ..... | ..... | ..... | ..... |
| | | Powerformer | 25,000 bbls. | ..... | Under Constr. | 2nd Qtr., 1958 | ..... | Esso | Bechtel |
| | | Alkylation | 10,000 bbls. | ..... | Under Constr. | 3rd Qtr., 1959 | ..... | Foster Wheeler | Foster Wheeler |
| | | LPG Storage | 1,000,000 bbls. | ..... | Complete | ..... | ..... | ..... | ..... |
| | | Solvents Hydrofiner | 3,600 bbls. | $75,000 | Engineering | 1958 | Staff | Parsons | Parsons |
| | | Sulfuric Acid Alkylation | 10,000 bbls. | ..... | Under Constr. | Sept., 1958 | ..... | Foster Wheeler | Foster Wheeler |
| Ethyl Corp. | Baton Rouge | Vinyl-Chloride Monomer Pet. | ..... | ..... | Under Constr. | June, 1958 | ..... | Catalytic | Catalytic |
| Firestone | Orange | Exp. Butadiene Plt. | 20,000 tons/yr. | $1,400,000 | Engineering | Summer 1958 | ..... | Catalytic | Catalytic |
| Gulf Oil | Pt. Arthur, Texas | Greasemaking; Packaging | ..... | ..... | Under Constr. | July, 1958 | ..... | Sumner Sollitt | Sumner Sollitt |
| | | Platformer | 26,000 bbls. | ..... | Under Constr. | 1958 | UOP | Procon | Procon |
| | | Gasoline Processing | 10,000 bbls. | $4,000,000 | Under Constr. | Late, 1958 | UOP | Procon | Procon |
| | | Benzene Plt. | 82,000 gals. | $6,800,000 | Under Constr. | Early 1959 | UOP | Procon | Procon |
| J. M. Huber | Borger, Texas | Furnace Black | 20-30,000,000 lbs./yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| Humble | Baytown, Texas | FCC | 51,200 bbls. | ..... | Under Constr. | 1958 | ..... | Foster Wheeler | Foster Wheeler |
| | | Ethylene Recovery Plt. | 80,000,000 lbs./yr. | ..... | Under Constr. | July, 1958 | ..... | Kellogg | Kellogg |
| | | Hydrodesulfurization Unit II | 43,200 bbls. | ..... | Under Constr. | 1958 | ..... | Parsons | Parsons |
| | | Butyl Exp. | 13,000 tons/yr. | ..... | Under Constr. | 1958 | ..... | Kidde Engrs. | Staff |
| | | Varsol Hydrofining | 6,000 bbls. | ..... | Under Constr. | May, 1958 | ..... | Hudson | Hudson |
| | | Phenol Lube Plt. No. 2 | 31,500 bbls. | ..... | Engineering | Aug., 1958 | ..... | Kellogg | Brown & Root |
| | | Exp. Paraxylene Unit | 9,000,000 lbs./yr. | ..... | Engineering | Oct., 1958 | ..... | Staff | Staff |
| | Kleberg County, Texas | Gas Process & Cycling Plt. | 750 Mmcf | $75,000,000 | Planning | Mid 1959 | ..... | ..... | ..... |
| | Fluor Bluff, Tex. | Exp. Gasoline Plt. | ..... | $4,000,000 | Under Constr. | 1958 | ..... | Staff | Humble |
| Jefferson Chemical | Port Neches, Texas | Inc. Ethylene Cap. | ..... | ..... | Under Constr. | Late 1958 | S&W | S&W | S&W |
| | | Inc. Ethylene Glycol Cap. | | | | | | | |
| | | Inc. of Ethylene Oxide Cap. | ..... | ..... | Under Constr. | ..... | Scientific Design | Scientific Design | Scientific Design |
| La Gloria Oil & Gas | Falfurrias, Texas | Exp. Gaso. Plt. | 2,200 bbls. | ..... | Complete | ..... | ..... | ..... | Hudson |
| Lone Star Producing Company | Atascosa County, Texas | *Natural gas treat. Plant | 1 Mmcfd | $3,750,000 | Under Constr. | ..... | ..... | Gas Plant Constr. | Gas Plant Constr. |
| Magnolia | Beaumont, Texas | Crude Distill. | 100,000 bbls. | ..... | Under Constr. | Late 1958 | ..... | Foster Wheeler | Foster Wheeler |
| | | Alkylation Unit | 8,000 bbls. | ..... | Under Constr. | 1958 | Esso | Staff, Braun | Braun |
| | | Sulfur Recovery Unit | 70 light tons | ..... | Under Constr. | 1958 | ..... | Foster Wheeler | Foster Wheeler |
| | | Sovafiner | 30,000 bbls. | ..... | Under Constr. | Late, 1958 | Socony Mobil | Staff, Foster Wheeler | Staff, Foster Wheeler |
| | | Exp. LPG Fractionation | ..... | ..... | Under Constr. | 1958 | ..... | Magnolia, Fluor | Fluor |
| McBride Refining Co. | Port Brownsville, Texas | Ref. Expan. | †12,500 bbls. | $2,500,000 | Planned | ..... | ..... | ..... | ..... |
| Monsanto | Texas City | Exp. Acrylonitrile Plt. | 100,000,000 lbs./yr. | ..... | Under Constr. | 1958 | ..... | ..... | ..... |
| | | Inc. Styrene Monomer Cap. | †40,000,000 lbs./yr. | ..... | ..... | June, 1958 | ..... | ..... | ..... |
| Neches Butane Products | Port Neches, Texas | Butadiene Plt. Exp. | 300,000 tons/yr. | ..... | Under Constr. | Mid, 1958 | ..... | Foster Wheeler | Foster Wheeler |
| Northeast Texas Chemical Co. | East Texas | Chemical and Fertilizer Plt. | ..... | ..... | Planning | ..... | ..... | Texas | Beck |
| Odessa Styrene | Odessa, Texas | Styrene Plt. | 40,000,000 lbs./yr. | $5,000,000 | Complete | ..... | UOP | Fish | Fish |
| Petroleum Chemicals | Lake Charles | Anhydrous Ammonia | 100,000 tons/yr. | $12,500,000 | Under Constr. | 1958 | ..... | Foster Wheeler | Foster Wheeler |
| | | Ethylene Plt. | 200,000,000 lbs./yr. | ..... | Complete | ..... | ..... | Lummus | Lummus |
| | | Butyl Rubber Plt. | 30,000 tons/yr. | $17,000,000 | Engineering | Early 1959 | ..... | Foster Wheeler | Foster Wheeler |
| Petro-Tex | Houston | *Sulfuric Acid Alkylation Plt. | 3,000 Nald. | ..... | Under Constr. | Early 1959 | ..... | ..... | ..... |
| Phillips Chemical | Gulf Coast | Carbon Black | 64,000,000 lbs./yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| Phillips Petroleum | Sweeny, Texas | Cat. Reformer; Desulfurization | 16,000 bbls. | ..... | Under Constr. | ..... | ..... | Phillips | Fluor |
| | Borger | Pentane Isomerization | 13,500 bbls. | ..... | Complete | ..... | UOP | Staff | Staff |
| Reef Fields Gasoline Corp. | Howard County, Texas | 67 M M cfd | ..... | ..... | Under Constr. | Spring, 1958 | ..... | Delta | Delta |
| Shamrock Oil & Gas | Dumas, Texas | Sulfuric Acid Plt. | 75 tons | $850,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Shell Oil | Norco | Cat. Gasoline Fractionator | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Platformer | 16,000 bbls. | ..... | Under Constr. | Aug., 1958 | ..... | Procon | Procon |
| | | *Acrolein Plant | 35,000,000 lbs./yr. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Sinclair Refining | Corpus Christi | Cat. Reformer | 6,500 bbls. | ..... | Under Constr. | Spring 1958 | ..... | Fluor | Fluor |
| | | Gaso. Fractionation | 5,400 bbls. | ..... | Under Constr. | Spring 1958 | ..... | Fluor | Fluor |
| | Houston | Gaso. Fractionation | 27,000 bbls. | ..... | Under Constr. | 1958 | ..... | Fluor | Fluor |
| | | Udex Paraxylene | 50,000,000 lbs./yr. | $6,000,000 | Engineering | Early 1959 | UOP | Badger Mfg. | Badger Mfg. |
| | | Steam Generating & Water Treating | 250,000 lbs. hr. | $1,500,000 | Under Constr. | Early 1959 | ..... | Kidde Engrs. | Kidde Const. |
| | Hulldale Field, Texas | Desulfurizer | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Spencer Chemical | Orange, Texas | Polyethylene Exp. | 90,000,000 lbs./yr. | ..... | Under Constr. | Summer, 1958 | ..... | Staff | Quaker |
| Suntide Refining | Corpus Christi | Gas Recovery Unit | 2,000 bbls. | $275,000 | ..... | May, 1958 | UOP | Staff | Staff |
| Texas Eastmen | Longview, Tex. | *Exp Polyethylene Plant | 85,000,000 lbs./yr. | ..... | Engineering | Mid 1958 | Girdler | Girdler | Girdler |
| Texas Natural Gasoline Corp. & Tennessee Gas Transmission | New Orleans | *Natural Gasoline Plant | 150 Mmcfd | ..... | Under Constr. | Nov., 1958 | ..... | ..... | ..... |
| The Texas Co. | Port Arthur | Power Plt. | ..... | ..... | Under Constr. | 1958 | ..... | Jackson & Moreland | Texaco |
| | | Crude Unit | 85,000 bbls. | ..... | Under Constr. | 3rd Qtr., 1958 | ..... | Fluor | Fluor |
| | | Cat. Cracker | 60,000 bbls. | ..... | Under Constr. | 3rd Qtr., 1958 | ..... | Kellogg | Kellogg |
| | | Inc. Alkylation | 2,000 bbls. | ..... | Under Constr. | 3rd Qtr., 1958 | ..... | Staff | Staff |
| | | Cat. Reformer | 20,000 bbls. | ..... | Engineering | 4th Qtr., 1958 | ..... | UOP | ..... |
| | | Udex Unit | 28,000 bbls. | ..... | Engineering | 4th Qtr., 1958 | ..... | UOP & Others | Staff & Others |
| Tidewater Oil | New Hope, Texas | Injection Plt. | 15 Mmcf | $700,000 | Under Constr. | ..... | ..... | Olsen | Olsen |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 240*

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| United Rubber & Chemical | Baytown, Texas | Synthetic Rubber Facil. | ..... | ..... | Under Constr. | 1958 | ..... | Day & Zimmermann | Tellepsen |
| U. S. I. Chem. Corp. | Houston | *Polyethylene Plant | 75,000,000 lbs./yr. | ..... | Under Constr. | Early 1959 | ..... | Kellogg | Kellogg |
| Wisco Gas Processing | Wise County, Texas | Gasoline Plt. | 150 Mmcf | $4,000,000 | Complete | ..... | ..... | Olsen | Olsen |
| Wyandotte Chemical | Geismar, La. | Ethylene-Oxide Glycol | 60,000,000 lbs./yr. | $8,000,000 | Complete | ..... | Shell | Lummus | Lummus |
| **ROCKY MOUNTAIN** | | | | | | | | | |
| Apache Powder Co. | Curtiss, Ariz. | Ammonia Synthesis Plt. | ..... | $1,000,000 | Complete | ..... | ..... | Girdler | Staff |
| Bay Petroleum | Denver | Cat. Reformer | 3,800 bbls. | $1,200,000 | Complete | ..... | ..... | Kellogg | Kellogg |
| Carter Oil Co | Billings, Mont. | Increase Crude Cap. | 34,500 bbls. | $1,500,000 | Under Constr. | May, 1958 | ..... | Esso | Staff |
| El Paso Natural Gas Products Co. | Gallup, N.M. | Refinery; Alkylation, Cat. Reforming, Cat. Cracking, Vacuum Crude Unit | 9,000 bbls. | $10,000,000 | Complete | ..... | UOP | Sweco | Sweco |
| | Bloomfield, N.M | Natural Gasoline | 165 Mmcf | ..... | Complete | ..... | ..... | Stearns-Roger | Stearns-Roger |
| Farmers Union Central Exchange | Laurel, Mont. | Naphtha Unifiner | 5,100 bbls. | | | | | | |
| | | Platformer | 4,400 bbls. | $3,800,000 | Under Constr. | May, 1958 | UOP | UOP | Treco |
| | | Distillate Unifiner | 7,100 bbls. | | | | | | |
| Phillips Petroleum | Woods Cross, Utah | Cat Reformer | 3,700 bbls | $1,100,000 | Under Constr. | Summer 1958 | UOP | Procon | Procon |
| | Great Falls, Mont. | Asphalt Exp. | ..... | ..... | Under Constr. | Spring 1958 | ..... | Staff | ..... |
| Salt Lake Refg. | Salt Lake City | Reformer | 6,000 bbls. | ..... | Complete | ..... | UOP | ..... | Fluor |
| Socony Mobil | Casper, Wyo. | Cat. Reforming | 3,250 bbls. | ..... | Complete | ..... | ..... | Pritchard | Pritchard |
| | | Cat. Hydrodesulfurization | 3,400 bbls. | ..... | Complete | ..... | ..... | Pritchard | Pritchard |
| Southwestern Agro-chemical Corp. | Chandler, Ariz. | Ammonia Synthesis Plt. and relate facilities | 60 tons | $5,000,000 | Planning | June, 1959 | ..... | ..... | ..... |
| Tennessee Gas | Lea County, N.M. | Gas Process Plt. | 10 Mmcf | $2,000,000 | Under Constr. | 1958 | ..... | O. L. Olsen | O. L. Olsen |
| The Texas Co. | San Juan County, Utah | Gasoline Plt. | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Utah Oil Refining | Salt Lake City | CO Boiler for FCU | ..... | $970,000 | Complete | ..... | ..... | Stearns-Roger | Stearns-Roger |
| | | Crude Unit | 35,000 bbls. | $2,000,000 | Under Constr. | June, 1958 | ..... | Fluor | Fluor |
| **WEST COAST** | | | | | | | | | |
| California Ammonia Co. | Lathrop, Calif. | *Ammonia Synthesis Plt. | 100 tons | $5,000,000 | Engineering | 1959 | ..... | Macco | Macco |
| Cal-Mex Oil & Refining | San Diego | Refinery | 20,000 bbls. | ..... | Engineering | Early 1959 | ..... | Parsons | Parsons |
| Douglas Oil | Bakersfield | Depropanizer Unit | 1,800 bbls. | ..... | Complete | ..... | UOP | Macco | ..... |
| | | *Unifiner | 1,300 bbls. | ..... | Complete | ..... | UOP | Macco | Macco |
| | Los Angeles | Topping Plt. | 12,000 bbls. | ..... | Engineering | 1959 | ..... | Sweco | ..... |
| du Pont | Antioch, Calif. | Fluorinated Hydrocarbons, Tetraethyl Lead | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Ethyl Corp. | San Francisco | Anti-knock Compound Mfg. Plt. | ..... | ..... | ..... | Mid 1958 | ..... | Braun | Braun |
| Fletcher Oil | Wilmington, California | Unifiner Platformer | ..... | ..... | Under Constr. | Spring, 1958 | UOP | Parsons | Parsons |
| Hercules Powder | Hercules, Calif. | Urea Plt. | 60 tons | ..... | Under Constr. | Oct., 1958 | Vulcan-Inventa | Vulcan | Vulcan |
| Richfield Oil | Everett, Wash. | Refinery | 50,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| | Los Angeles | Benzene Plt. | 18,000,000 gal./yr. | ..... | Under Constr. | May, 1958 | ..... | ..... | ..... |
| Shell Chemical | Domingues, Calif. | Exp. Isopropyl Alcohol Facl. | ..... | ..... | Under Constr. | Fall 1958 | ..... | ..... | ..... |
| Shell Development Co. | Emeryville Calif. | *Research Lab. | ..... | $500,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Shell Oil | Anacortes, Wash. | Alkylation Unit | ..... | ..... | Engineering | Mid 1958 | ..... | Fluor | Fluor |
| | Wilmington | Boiler for Cat. Cracker | 200,000 lbs. | $1,000,000 | Under Constr. | ..... | ..... | ..... | ..... |
| | | Platformer | 16,000 bbls. | ..... | ..... | 1958 | ..... | Kaiser | Kaiser |
| | | Crude De-Salting Unit | 70,000 bbls. | $650,000 | Complete | ..... | ..... | Macco | Staff |
| Standard Oil (Calif.) | Everett, Wash. | Refinery | 60,000 bbls. | $75,000,000 | Planning | 1961 | ..... | Staff | ..... |
| | Bakersfield | Cat. Reformer | 5,000 bbls. | $4,500,000 | Under Constr. | Mid 1958 | ..... | Staff-Bechtel | Bechtel |
| | Richmond | Cat. Reformer | 20,000 bbls. | $11,000,000 | Under Constr. | Mid 1958 | ..... | Staff-Bechtel | Bechtel |
| | | Paraxylene Plt. | ..... | ..... | Under Constr. | ..... | ..... | Staff-Bechtel | Rosendahl Corp. |
| | El Segundo | Deisobutaniser | †300 bbls. | $1,500,000 | Under Constr. | 1958 | ..... | Staff | Macco |
| | | *Steam Generating Plant | 275,000 lbs./hr. | $2,000,000 | Engineering | March, 1959 | ..... | Fluor | Fluor |
| The Texas Co. | Anacortes, Wash. | Refinery | 40,000 bbls. | ..... | Under Constr. | Jan., 1959 | ..... | Bechtel | Bechtel |
| | Los Angeles | Udex Unit | 7,500 bbls. | ..... | Under Constr. | 4th Qtr., 1958 | ..... | UOP | Parsons |
| Tidewater | Avon, Calif. | Platinum Cat. Reformer | 22,500 bbls. | ..... | Complete | ..... | Houdry | Bechtel | Bechtel |
| | | Steam Generating Plt. | 50,000 lbs./hr. | ..... | ..... | 3rd Qtr., 1958 | ..... | Bechtel | Bechtel |
| U.S. Oil & Refining | Tacoma, Wash. | Refinery | 15,000 lbs. | ..... | Under Constr. | 1958 | UOP | J. B. Gill | J. B. Gill |
| **OUTSIDE U.S.A.** | | | | | | | | | |
| **Alaska & Hawaii** | | | | | | | | | |
| Alaska-Yukon Refinery | Haines | Refinery | 7,500 bbls. | $6,000,000 | Engineering | 1958 | ..... | Treco | Treco |
| Standard Oil (Calif.) | Honolulu | Refinery | 35,000 bbls. | $40,000,000 | Engineering | 1960 | ..... | Staff | ..... |
| **Canada** | | | | | | | | | |
| British American Oil | Clarkson, Ont. | Offsite Facilities | ..... | $4,000,000 | ..... | ..... | ..... | Fluor | Fluor |
| | Edmonton | Cat. Reformer | 4,000 bbls. | 2,900,000 | Complete | ..... | ..... | Lummus | Lummus |
| | | Cat. Desulfurization | 6,300 bbls. | | Complete | ..... | Atlantic | Lummus | Lummus |
| | Nevis, Alberta | Gasoline Plt. | 30,000 gals. | ..... | ..... | ..... | ..... | ..... | ..... |
| | Pincher Creek | Sulfur Recovery | 225 tons | ..... | Under Constr. | ..... | ..... | Parsons | Parsons |
| | | Gas Cycling | 2,200 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | Port Moody | Refinery | 20,000 bbls. | ..... | Under Constr. | Late 1958 | ..... | Kellogg | Kellogg |
| | Moose Jaw, Sask. | *Cat Reformer & HDS Unit | 5,400 bbls. | $4,000,000 | Under Constr. | Late 1958 | Atlantic | Lummus | Lummus |
| | | *Gas Splitter | ..... | ..... | Engineering | Fall 1958 | UOP | UOP Procon | Procon |
| | Montreal | Gaso. Splitter | 12,000 bbls. | $750,000 | Under Constr. | Late 1958 | ..... | Procon | Procon |
| British Petroleum | Near Montreal | Refinery | 30,000 bbls. | $30,000,000 | Planning | ..... | ..... | ..... | ..... |
| Canadian Husky Oil | Ft. William | Dieselformer & Tankage | 1,000 bbls. | $700,000 | Under Constr. | ..... | Husky | ..... | Poole-Pritchard |
| Canadian Oil Co., Ltd. | Corunna | Crude Unit | 20,000 bbls. | $3,000,000 | Engineering | 1959 | ..... | Kellogg | Kellogg |
| Consumers, Cooperative Refinery, Ltd. | Regina, Sask. | Coking Unit | 3,000 bbls. | $1,300,000 | Under Constr. | Late 1958 | ..... | UOP; Staff | Fluor; Staff |
| Canadian Industries, Ltd. | Edmonton, Alberta | Inc. Polythene | 40,000,000 lbs./yr. | ..... | Under Constr. | 1959 | ..... | ..... | Poole Constr. Co., Ltd. |

* First appearance in tabulation. † Added capacity

*Construction BOXSCORE Continued on Page 243*

# Here's a pump you can use anywhere GOULDS self-priming centripetal pump (Fig. 2520)

*pumps liquid... air ... liquid and air*

As a scavenger . . . handy transfer . . . for cleaning up—which way can this versatile Goulds pump work for you?

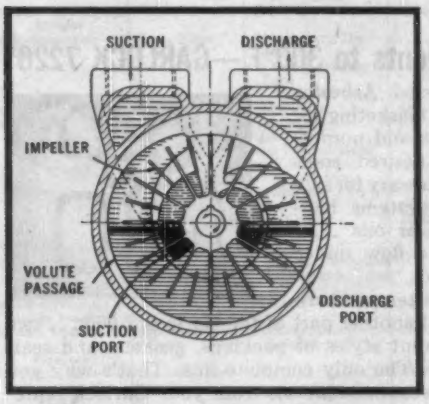
You can use it for almost anything.

Because it pumps air and liquid in any combination, it handles foaming solutions and emulsions easily. It's ideal for pilot plant work, for cleaning operations.

Once primed, it stays primed. It won't air-bind. Even with loops or leaks in your suction line, its high air-handling capacity will keep liquids moving.

Compact, lightweight, portable—it's ready in all-iron construction, or in stainless steel for corrosive service. It's offered as a mobile unit (illustrated), pump-motor unit, or pump only for V-belt drive. The pump itself weighs 42 pounds. With 1½ inch suction and discharge, capacities go to 60 GPM, heads to 80 feet.

There's a complete description of the Liquid Ring Pump in Bulletin 725.6; you can get a copy from us or from your Goulds representative.




This new self-priming Goulds pump eliminates air-binding by a unique use of *centripetal* action. The impeller forces liquids along a volute casing, building up pressure as the liquid moves to the narrow end. This pressure sets up a liquid piston action between each set of blades, forcing liquids to the center of the pump. The liquid piston forces any air entrapped in the center up through the outlet.

**GOULDS PUMPS, INC.**

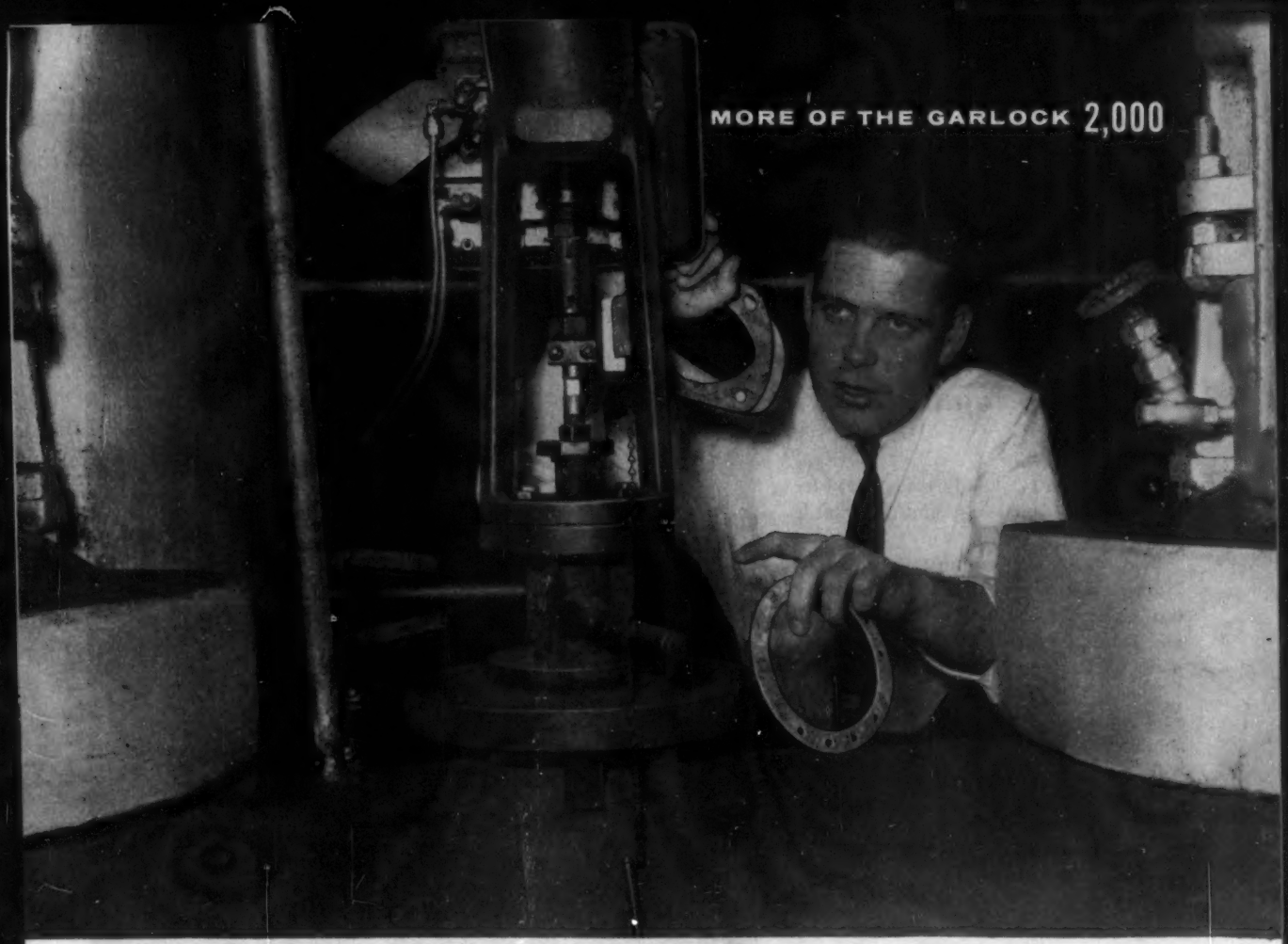
**Main Office and Works, Seneca Falls, New York**

Branches and Representatives in principal cities

In Canada: The A. R. Williams Machinery Co., Ltd.



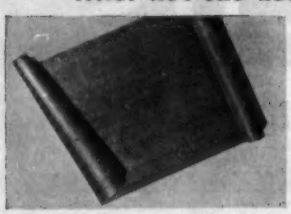
For more data on advertised products, use Readers' Service Cards, last page.




# "If you're gasketing against steam or gases to 700°F., try GARLOCK 900"

Most engineers agree, that safe positive sealing of pipe flanges and gasketed joints on systems handling steam, gas, or air to 700° F. is best accomplished with a gasket material such as Garlock 900 which is resistant to plastic flow, but is compressible enough to compensate for surface irregularities. Garlock 900 is made from long fiber Canadian asbestos and a special rubber compound bonded under pressure and vulcanized into a homogeneous structure . . . compressible, yet resistant to plastic flow.

## "...for hot oils use GARLOCK 7021"



Sealing against hot oils to 700° F. on pipe lines, internal combustion engines, compressors, or other high temperature applications calls for a strong dense gasketing such as Garlock 7021 . . . oil resistant, compressible, yet unusually resistant to plastic flow under heavy bolt loads.

## "...for solvents to 300°F.—GARLOCK 7228"

This Compressed Asbestos and Neoprene Gasketing for gasketed joints and pumps, provides the desired compressibility necessary for safe gasketing on systems handling solvents or oils . . . without plastic flow under heavy bolt loads.

These high temperature gaskets are still another part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. That's why you get unbiased recommendations from your Garlock representative. Call him or write for Gasket Folder AD 162.

**THE GARLOCK PACKING COMPANY, Palmyra, N.Y.**

**For prompt service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.**

GARLOCK

*Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products*

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Canadian Petrofina | Montreal | Increase Cap. | 20,000 bbls. | $3,000,000 | Under Constr. | 2nd Half 1958 | ..... | Staff | Procon (Canada) |
| Cities Service | Toronto | New Refinery | 20,000 bbls. | $26,000,000 | Under Constr. | Dec., 1958 | ..... | Braun, Ltd. | Braun, Ltd. |
| Excelsior Refineries | The Pas, Manitoba | Refinery | 2-3,000 bbls. | $1,500,000 | Planning | ..... | ..... | ..... | ..... |
| Imperial Oil | Sarnia | Petrochemical Plt. | ..... | $26,500,000 | Under Constr. | Summer 1958 | ..... | Canadian Bechtel | Canadian Bechtel |
| | Ioco, B.C. | Powerformer Prefractionator, Hydrofiner | 5,800 bbls. | $4,000,000 | Complete | ..... | Esso | Canadian Bechtel | Canadian Bechtel |
| | Calgary | Crude Cap.<br>Cat. Cracker<br>Powerformer<br>Offsite Facilities | 14,700 bbls.<br>6,000 bbls.<br>2,700 bbl.. | $17,000,000 | Engineering | Late 1959 | ..... | Canadian Betchel; Staff | Canadian Betchel |
| | Winnipeg | Add. Crude Cap.<br>Powerformer<br>Associated Facil. | 2,500 bbls.<br>2,850 bbls.<br>1,100 bbls. | $4,500,000 | Complete | ..... | ..... | ..... | Foster Wheeler |
| McColl-Frontenac | Montreal East | Hydrotreater | 10,000 bbls. | $1,000,000 | Complete | ..... | Texas Co. | Foster Wheeler | Foster Wheeler, Ltd. |
| Midland Pet. | Stettler, Alta. | Crude Refinery | 4,000 bbls. | $2,000,000 | Under Constr. | ..... | ..... | ..... | ..... |
| North Star Oil, Ltd. | St. Boniface, Manitoba | *Platformer Unifiner | 2,700 bbls. | $1,100,000 | Engineering | Late 1958 | UOP | UOP Procon | Procon |
| Pacific Petroleum, Ltd. | Dawson Creek | Vacuum Distill. Unit | ..... | $380,000 | ..... | ..... | ..... | ..... | ..... |
| Pacific Petroleum & Phillips Petroleum | Taylor, B.C. | Refinery | ..... | ..... | Complete | ..... | ..... | Stearns-Roger | Stearns-Roger |
| Royalite Oil | Kamloops, B.C. | Platformer | 1,000 bbls. | $750,000 | Complete | ..... | UOP | UOP | Treco |
| Shell Oil (Canada) | Bronte, Ont. | Refinery | ..... | ..... | Considering | ..... | ..... | ..... | ..... |
| | Montreal | HF Alkylation | 1,500 bbls. | $4,000,000 | Under Constr. | 1958 | UOP | UOP<br>Treco, Staff | Treco |
| | Montreal, East | Exp. Asphalt Plt. | ..... | $450,000 | Planning | 1958 | ..... | Staff | Staff |
| | Quebec | Tetramer Unit | ..... | ..... | Under Constr. | 1958 | ..... | Treco, Staff | Treco |
| | | Resin Plt. | ..... | $1,000,000 | Under Constr. | 1958 | ..... | Treco, Staff | Treco |
| | Cochrane, Alberta | Exp. Treating Plt. | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | Vancouver | Solvent Plt. | ..... | $600,000 | Under Constr. | 1958 | ..... | Fluor, Staff | Staff |
| Sherritt-Gordon Mines, Ltd. | Fort Saskatchewan, Alta. | Anhydrous Ammonia | 75 tons | $24,000,000 | Planned | ..... | ..... | ..... | ..... |
| Union Carbide, Canada | Montreal East, Quebec | Ethylene Glycol & Polyethylene Exp. | ..... | $4,000,000 | Complete | ..... | ..... | Staff | ..... |
| **LATIN AMERICA** | | | | | | | | | |
| **Brazil** | | | | | | | | | |
| Alba (Borden) | Cubatao | Methanol, Formaldehyde, Synthetic Resins | 30 tons | $3,500,000 | Under Constr. | Mid 1958 | Vulcan | Vulcan Girdler | Staff Girdler Austin; Montreal, S.A. |
| Petroleo Brasileiro | North Brazil | Refinery | 25,000 bbls. | ..... | Studying | ..... | ..... | ..... | ..... |
| | South Brazil | Refinery | 70,000 bbls. | ..... | Studying | ..... | ..... | ..... | ..... |
| | Mataripe | Atmospheric & Vacuum Distill. Units, Cat. Crkr., Gas Recovery, Wax Treating | 37,000 bbls. | ..... | Engineering | 1960 | Kellogg | Kellogg | Kellogg Brasileira; Montreal, S. A. |
| | Rio de Janeiro | New Refinery | 90,000 bbls. | $60,000,000 | Engineering | Early 1960 | ..... | Foster Wheeler | ..... |
| Uhde | Cubatao | Urea Plt. | ..... | ..... | ..... | ..... | ..... | Uhde | Uhde |
| Union Carbide | Cubatao | Polyethylene | ..... | ..... | Under Constr. | 1958 | ..... | Brown & Root | Brown & Root Ltd. |
| **Colombia** | | | | | | | | | |
| Empresso Colombiana de Petroleos | El Centro | Plt. Modernization | 2,000 bbls. | $3,000,000 | Engineering | 1958 | ..... | Parsons | Parsons |
| | Barranca Bermeja | Exp. Propane Recovery | 1,000 bbls. | $1,000,000 | Planning | ..... | ..... | ..... | ..... |
| **Chile** | | | | | | | | | |
| Empresa Nacional del Petroleo | Concon | *Refinery Exp: | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Crude Topping | 24,000 bbls. | ..... | ..... | ..... | ..... | Kellogg | ..... |
| | | Vacuum Unit | 10,080 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Orthoflow FCC Unit | 12,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | SBK Cat. Desulfurization | 6,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Alkylation Unit | 1,100 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| **Cuba** | | | | | | | | | |
| Esso Standard | Havana | Ref. Expan.; Distillation, Polymerization, Powerforming, Cat. Cracking | To 35,000 bbls. | $30,000,000 | Complete | ..... | Esso | McKee | McKee |
| Refinadora Cabaiguan | Cabaigun | Ref. Expan. | 5,000 bbls. | $3,000,000 | Planning | 1959 | ..... | Treco | ..... |
| **Ecuador** | | | | | | | | | |
| Anglo-Ecuadorian Oilfields, Ltd. | Santa Elena Ancon | *Atmospheric Distillation | ..... | ..... | Under Constr. | Mid 1958 | UOP | Procon | Procon |
| | | *Thermal Cracking Units | ..... | ..... | Under Constr. | Mid 1958 | UOP | Procon | Procon |
| **Mexico** | | | | | | | | | |
| Central Minera, S.A. | Tenixtepec | Sulphur Plt. | 1,000 tons | $3,500,000 | Complete | ..... | ..... | ..... | ..... |
| Pemex | Ciudad Madero | Topping<br>Cat. Cracking<br>Gas Concentration; HF Alkylation; Polymerization; Sulfur Plt. | 100,000 bbls.<br>25,000 bbls. | $25,700,000 | Under Constr. | Mid 1958 | Phillips, Esso, UOP | McKee | Staff |
| | Salamanca | Grease Plt. | 25 tons | $1,700,000 | Engineering | ..... | ..... | McKee | Staff |
| | | Cat. Cracker | 15,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| | Posa Rica | Topping Plt. | 10,000 bbls. | $1,250,000 | Engineering | ..... | ..... | Staff | Staff |
| **Netherlands Antilles** | | | | | | | | | |
| Largo Oil & Transport | Aruba, N. A. | *Revamp Distillation & Visbreaking Units | ..... | ..... | Engineering | Nov., 1959 | ..... | Kellogg | Kellogg |
| **Panama** | | | | | | | | | |
| Refiner a Petroquimica de Panama | Colon | Refinery | 55,000 bbls. | $33,000,000 | Engineering | ..... | ..... | Foster Wheeler | Foster Wheeler |
| Refineria Panama | Las Minas Bay, Coson | Refinery; Petrochemicals | 70,000 bbls. | $50,000,000 | Under Constr. | 1959 | ..... | Pet. Comb. & Eng. Co. | Pet. Comb. & Eng. Co. |
| **Paraguay** | | | | | | | | | |
| Compagnie Fives-Lille | Asuncion, Paraguay | *Refinery | 10,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| **Peru** | | | | | | | | | |
| Helios, S.A. | San Andres | Fertilizer Plt. | 130,000 tons | ..... | Planning | ..... | ..... | ..... | ..... |
| **Puerto Rico** | | | | | | | | | |
| Commonwealth Oil Refining | Guayanilla Bay | Refinery Exp. | 75,000 bbls. | $9,500,000 | Planning | Mid 1959 | ..... | ..... | ..... |
| Union Carbide Caribe | Ponce | Ethylene-Glycol | 500,000 lbs. | $28,500,000 | Planning | Mid 1958 | ..... | Brown & Root | Brown & Root |
| **Trinidad** | | | | | | | | | |
| W. R. Grace & Co. | Trinidad | Chemical Plt. | ..... | $10,000,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Trinidad Oil Co., Ltd. | Pointe a-Prierre | *Processing Units | ..... | ..... | Under Constr. | 2nd Qtr., 1958 | UOP | Procon | Procon |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 244*

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| **Uruguay** | | | | | | | | | |
| Administracion Nacional de Combustibles Alcohol Y Portland | Montevideo | Crude Distill. | 28,000 bbls. | $12,000,000 | Engineering | Late 1959 | ..... | | |
| | | Vac. Distill. | 10,000 bbls. | ..... | ..... | ..... | ..... | | |
| | | Cat. Cracker | 5,000 bbls. | ..... | ..... | ..... | ..... | | |
| | | Cat. Reformer | 3,000 bbls. | ..... | ..... | ..... | ..... | | |
| | | Gas Concent. & Bottling | ..... | ..... | ..... | ..... | ..... | Kellog | Staff |
| | | Gas Sweetening | 4,500 bbls. | ..... | ..... | ..... | ..... | | |
| | | Sulfur Recovery | 6 tons | ..... | ..... | ..... | ..... | | |
| | | Power Plt. & Offsite Facil. | 3,600 KW | ..... | ..... | ..... | ..... | | |
| **Venezuela** | | | | | | | | | |
| Cia Shell de Venezuela | Cardon | Distillation | 80,000 bbls. | $20,000,000 | Under Constr. | 3rd Qtr., 1958 | ..... | ..... | ..... |
| | | Alkylation | 2,300 bbls. | ..... | Under Constr. | 2nd Qtr., 1958 | ..... | ..... | ..... |
| Creole Pet. Corp. | Amuay Bay | Hydrofining Plt. | 17,000 bbls. | $3,000,000 | Under Constr. | ..... | ..... | Foster Wheler | Foster Wheeler |
| | | Lube Oil Plt. | 700 bbls. | $7,650,000 | Under Constr. | May, 1958 | Esso | Foster Wheeler | Foster Wheeler |
| | Lake Maracaibo | LPG Plt. | 17,000 bbls. | $11,173,000 | Under Constr. | 1958 | Creole | Tellepsen | Tellepsen |
| Socony Mobil | El Palito | *Refinery | 40,000 bbls. | $28,000,000 | Under Constr. | Late 1959 | ..... | ..... | ..... |
| Venesuelan Govt. | Venesuela | Ammonia Synthesis Gas | 120 tons | $1,000,000 | Planning | ..... | ..... | Air Products | Air Products |
| **EUROPE AND AFRICA** | | | | | | | | | |
| **Belgium** | | | | | | | | | |
| Esso Belgium | Antwerp | Vac. Distill. | 2,900 bbls. | $750,000 | Under Constr. | May, 1958 | ..... | Badger-Comprimo | Badger-Comprimo |
| | | Powerformer | 5,600 bbls. | $7,100,000 | Under Constr. | May, 1958 | Esso | Badger-Comprimo | Badger-Comprimo |
| | | Hydrofiner | 6,900 bbls. | | | | | | |
| Soc. Industrielle Belge des Petroles | Antwerp | Cat. Reformer | 10,000 bbls. | ..... | Under Constr. | 1958 | UOP | Kellogg; UOP | Kellogg |
| | | Hydrofiner | 10,000 bbls. | ..... | Under Constr. | 1958 | ..... | Kellogg | Kellogg |
| **Canary Islands** | | | | | | | | | |
| Cepsa | Las Palmas | *Ammonia | 90 tons | ..... | Engineering | Late 1958 | Hoechst | Uhde | Uhde |
| **Denmark** | | | | | | | | | |
| The Maersk Refinery | Copenhagen | Steam Cracker | 3,500 bbls. | ..... | Under Constr. | Spring 1958 | ..... | Foster Wheeler | Foster Wheeler |
| **Egypt** | | | | | | | | | |
| Anglo-Egyptian Oilfields | Suez | Cat. Reformer | 2,300 bbls. | ..... | Projected | ..... | ..... | ..... | ..... |
| Egyptian Govt. | Suez | Power Plt. | 10,000 KW. | $2,200,000 | Planned | 1960 | ..... | Italian | Firms |
| | | Mech. Workshop | ..... | $1,000,000 | Complete | ..... | ..... | ..... | Local |
| | | Atmos. Dist., Vac. Dist. & Lube Oils | 30,000 bbls. | $7,000,000 | Planning | 1960 | ..... | ..... | ..... |
| | | Vapor Recovery & Bottling | 70 tons | $1,000,000 | Planned | 1959 | ..... | Lummus | Lummus |
| | Alex | Atmos. & Vac. Dist. | 10,000 bbls. | $1,400,000 | Planning | ..... | ..... | ..... | ..... |
| | Cairo | Atmos. Dist. & Vac. Dist. | 10,000 bbls. | $1,400,000 | Planning | ..... | ..... | ..... | ..... |
| **England** | | | | | | | | | |
| British Petroleum | Kent | Hydrofiner II | 10,000 bbls. | ..... | Under Constr. | Mid 1958 | ..... | Kellogg | McAlpine, Wimpey |
| | | Two Copper Chloride Units | 8,000 bbls., ea. | ..... | Complete | ..... | ..... | W. J. Fraser | McAlpine, Wimpey |
| | | Alkylation Plt. | 2,250 bbls. | ..... | Complete | ..... | ..... | Lummus | |
| | | Cat. Reformer | 10,000 bbls. | ..... | Under Constr. | 1958 | ..... | UOP, Kellogg | McAlpine, |
| | | Thermal Reforming | 12,000 bbls. | ..... | Under Constr. | Mid 1958 | ..... | Kellogg | Wimpey |
| | | Udex Unit | 500 lbs. | ..... | Engineering | 1958 | ..... | UOP, Badger | McAlpine, Wimpey |
| Eastern Gas Board | Dunstable | Oil Gasification | 6,000,000 cu. ft. | ..... | Planning | Spring 1958 | ..... | H & G | H & G |
| | Pouders Encl. | Catalytic Oil Gasification | 0 mm cfd | ..... | Under Constr. | ..... | ..... | Power-Gas | Power-Gas |
| East Midland Gas Board | Northampton | Oil Gasification | 6,000,000 cu. ft. | ..... | Planning | ..... | ..... | H & G | H & G |
| Esso Petroleum Co. | Fawley | Ethylene & Butadiene Plt. | ..... | $27,000,000 | Under Constr. | Mid 1958 | ..... | Foster Wheeler | Foster Wheeler |
| | | Sulfur Plt. | 60 tons | $700,000 | Under Constr. | ..... | ..... | Foster Wheeler | Foster Wheeler |
| | | Crude Pipestill | 70,000 bbls. | $5,000,000 | Complete | ..... | ..... | Foster Wheeler | Foster Wheeler |
| | Milford Haven | Refinery | 100,000 bbls. yr. | $56,000,000 | Planning | Early 1960 | ..... | ..... | ..... |
| Hedon Chemicals | Hedon, Yorks | Vinyl Acetate | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| International Synthetic Rubber | Fawley | Synthetic Rubber | 50,000 ton/yr. | $12,000,000 | Engineering | ..... | ..... | Blaw Knox | Blaw Knox |
| Malta Gas Board | Valetta | Catalytic Oil Gasification | 1 Mmcfd | ..... | Under Constr. | Early 1959 | ..... | Power-Gas | Power-Gas |
| Mobil Oil Co., Ltd. | Coryton | Cat. Hydrodesulfurization | ..... | ..... | Pre-engineering | ..... | ..... | ..... | ..... |
| | | Crude Unit Exp. | 5,000 bbls. | ..... | Under Constr. | 1958 | ..... | Staff | Staff |
| Monsanto Chemicals | Britain | Add Polystyrene | ..... | ..... | Under Constr. | ..... | ..... | Staff | Staff |
| | | Styrene-Butadiene Copolymer Plt. | 4,000 ton/yr. | $14,000,000 | Planned | ..... | ..... | ..... | ..... |
| North Thames Gas Board | Romford | Refinery Tail Gas Reforming | 36,000,000 cu. ft. | ..... | Under Constr. | 1958 | ..... | H & G | H & G |
| North Western Gas Board | Manchester | *Pressure Oil Gasification | 7.5 Mmscf | ..... | Engineering | Dec., 1959 | Texaco & others | H&C | H&C |
| Petrochemicals, Ltd. | Partington, Nr. Manchester | Exp. Ethylene Plt. | 30,000 tons/yr. | ..... | Engineering | ..... | ..... | H.W.P. | H.W.P. |
| Shell Chemical | Shell Haven | Ammonia; Nitric Acid | 75,000 tons/yr. | $18,500,000 | Planning | 1958 | ..... | ..... | ..... |
| | | Fertiliser | ..... | $12,500,000 | Planning | ..... | ..... | ..... | ..... |
| | Partington | Ethylene Oxide | 25,000 tons/yr. | ..... | ..... | Mid 1958 | ..... | ..... | ..... |
| Shell Refining | Shell Haven | Atmospheric Distil. | 80,000 bbls. | ..... | Under Constr. | Late 1958 | ..... | S&W; E. B. Badger, Ltd. | E. B. Badger, Ltd. |
| | | Hydrodesulfurizer | 16,000 bbls. | ..... | Projected | 1960 | ..... | ..... | ..... |
| | Stanlow | *Udex Unit | ..... | ..... | ..... | Mid 1958 | UOP | ..... | ..... |
| South Eastern Gas Board | Isle of Grain | Oil Gasification | 18 Mmcf | ..... | Under Constr. | Fall 1958 | ..... | Power Gas | Power Gas |
| Southern Gas Board | Southampton | Refinery Tail Gas Reforming | 16 Mmcf | ..... | Under Constr. | Oct., 1958 | ..... | H & G | H & G |
| | Reading | Catalytic Oil Gasification | 7 mm cfd | ..... | Under Constr. | Early 1959 | ..... | Power-Gas | Power-Gas |
| **France** | | | | | | | | | |
| Compagnie de Raffinage Shell Berre | Petit Couronne | Distl. Unit | 80,000 bbls. | ..... | Under Constr. | 3rd Qtr., 1958 | ..... | ..... | ..... |
| | | Hydrodesulfurizer | 11,000 bbls. | ..... | Projected | 3rd Qtr., 1959 | ..... | ..... | ..... |
| | | *Platformer | 14,000 bbls. | ..... | Engineering | 1959 | ..... | Procon | Procon |
| Comp Francaise de Raffinage | Provence | Powerformer | 20,000 bbls. | ..... | Under Constr. | Mid 1958 | ..... | Foster Wheeler | Foster Wheeler |
| | Normandie | Ethylene Plt. | 30,000 tons/yr. | ..... | Engineering | 1958 | ..... | KIC | ..... |
| Esso Standard | Gironde Bordeaux | Refinery | 31,500 bbls. Expandable to 45,000 bbls. | ..... | Planning | 1959 | Esso | Lummus | Lummus |
| | Port Jerome | Powerformer | ..... | ..... | Under Constr. | 4th Qtr., 1958 | Esso | Foster Wheeler | Foster Wheeler |
| French Government & Prebelbroon Antar-Petroles de l'Atlantique | Strasburg | *Refinery | 70,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 247*

# GREAT DAY

## ...for the Sidewalk Superintendents

THIS is going to be a **big** one. What they're watching is the beginning of one of the largest, if not the largest crude processing unit in the world. It is designed to process **140,000 barrels per stream day**—that's enough crude to fill fifty miles of 24-inch pipeline. Yet, its precise instrumentation and controls will permit operation of the plant by a very small crew.

This new unit is typical of the large engineering and construction projects entrusted to McKee by the Petroleum Industry. The diversified talents, abilities and experience that enable us to design and build high-capacity, profit-making plants like this efficiently and economically can be invaluable to you on your new project.

**HERE'S WHAT THEY'LL SEE** erected and installed; 340 tons of steel; 3,500 cubic yards of concrete; furnaces with capacity to heat 10,000 homes; 20 miles of pipe; 6 acres of heat-exchange surface; motors and turbines with a total of 12,000 horsepower; 500 instruments and control devices. The completed unit will consume some 100,000 man-hours of engineering services, 700,000 man-hours of construction time.

**McKee**
**ENGINEERING & CONSTRUCTION**
**Services**

**Arthur G. McKee & Company • Engineers and Contractors**
*Headquarters:* McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
*Offices:* New York, N. Y. • Union, New Jersey • Washington, D. C.
*British Representatives of Metals Division:* Head, Wrightson & Co., Limited
*Canada:* Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto

*Inco high-temperature research note:*

# Effect on heat resistant alloys of the combustion products of Bunker "C" fuel oil

The use of Bunker "C" and other types of residual fuel oils for industrial heating poses a severe high temperature corrosion problem.

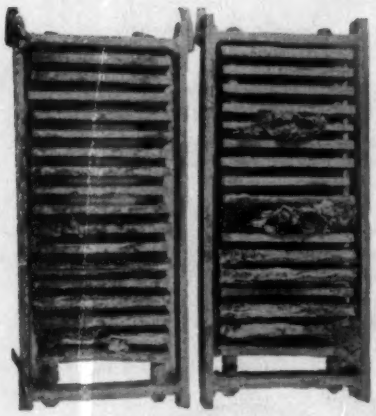
Combustion products from these fuels include a considerable amount of ash containing vanadium pentoxide, sodium and sulfur compounds, which have a low fusion temperature.

When this ash is liquid, it creates a fluxing action on the metals and high corrosion rates follow.

Since long field experience has shown all of the heat resistant alloy to be susceptible to this type of damage, an approach based on the addition of substances to the fuel oil to prevent the ash from becoming molten has been adopted.

**Inco High Temperature Engineering Service conducts in-plant tests**

Inco engineers—in cooperation with several Steam Power and Stationary Gas Turbine companies have conducted a series of in-plant tests in order to determine the behavior of certain high temperature alloys when exposed to Bunker "C" burned with or without additives.



**Test racks after exposure**

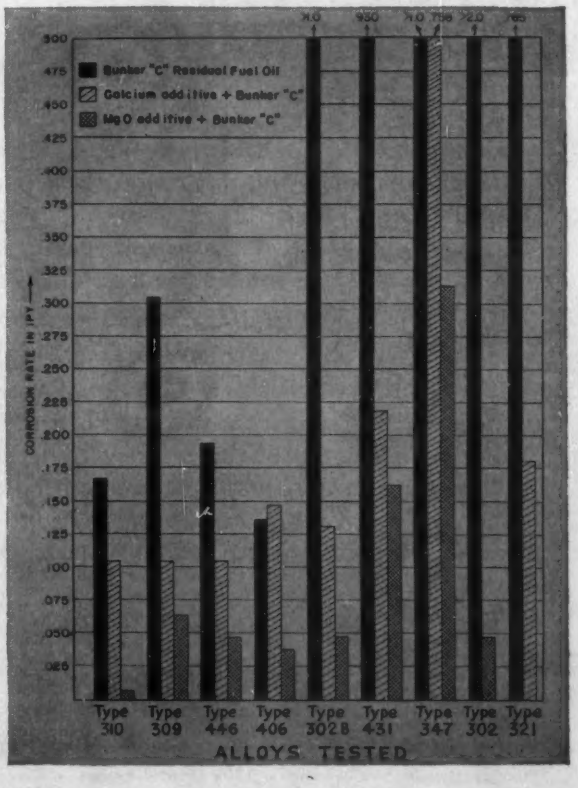
Each rack carried many specimens of different compositions, all precisely measured before installation. Corrosion rates are developed from these specimens by metallographic examination.

Corrosion results were obtained on both cast and wrought alloys as well as on some alloys with various coatings. The bar graph (below) shows the results of nine of the alloys tested. (Note for example, the performance of type 310 under the severe vanadium, sodium and sulfur environment.)

In general, data derived from this Inco High Temperature test points up the benefits of using additives when burning Bunker "C" fuel oil. It also provides a basis for material selection in terms of cost and length of service.

Inco has investigated many metals and alloys under hundreds of high temperature environments. If you have a metal problem involving high temperature performance let us help you. Send for our High Temperature Work Sheet . . . a form that makes it easy for you to outline your problem to us.

**THE INTERNATIONAL NICKEL COMPANY, INC.**
67 Wall Street New York 5, N. Y.



## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Houilleres du Bassin de Lorraine | Carling | Acetylene Plt. | ..... | ..... | Under Constr. | ..... | Koppers | SBA | SBA |
| Lorraine-Kuhlman | Dieuze (Moselle) | Styrene Monomer | ..... | ..... | Under Constr. | ..... | ..... | SBA | SBA |
| Manufacture Normande de Polyethylene | Gonfreville | Polystyrolene | ..... | ..... | Under Constr. | ..... | Koppers | Kuhlman | ..... |
| Marles-Kuhlmann | Gonfreville | Polyethylene | ..... | ..... | Under Constr. | ..... | Phillips | ..... | S.T.E.C. |
| Mobil Oil Francaise | Gravenchon | Ethylene Oxide | ..... | ..... | Under Constr. | ..... | Scientific Design | Staff | ..... |
| | | Lube Exp. | ..... | ..... | Engineering 2nd phase | 1958 | | | |
| | | | | | Planning 3rd phase | 1959 | | | |
| Omnium Francais de Petroles | Chalon sur Saone | *Refinery | 75,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| Potasse et Engrais Chimiques | Grand Couronne | Ammonia | ..... | ..... | ..... | ..... | SBA | KIC | KIC |
| Shell-Berre | Berre | Furfural Unit | 3,500 bbls. | ..... | ..... | ..... | ..... | Foster Wheeler | Foster Wheeler |
| Societe du Caoutchouc Butyl | Port Jerome | Butyl Rubber Plt. | 20,000 tons/yr. | ..... | Under Constr. | Fall 1958 | Esso | Braun | Braun |
| Soc. Francaise des Petroles BP | Dunkirk | Cat. Reformer | 10,000 bbls. | ..... | Under Constr. | 1958 | ..... | UOP; Kellogg | ..... |
| | Lavera | Distillation | 50,000 bbls. | ..... | Under Constr. | ..... | ..... | Foster Wheeler | Foster Wheeler |
| Soc. Nationale des Petroles D'Aquitaine | Lacq | Desulfurization | †140 Mmcf | ..... | Under Constr. | Mid 1958 | ..... | Foster Wheeler Soc. Chimique | Foster Wheeler Soc. Chimique |
| | | Distill. Recovery with Prod. Treat, & Fract. | †90 Mmcf | ..... | Under Constr. | Mid 1958 | ..... | Hydrocarbon | Hydrocarbon |
| | | Sulfur Recovery | †780 tons | $22,000,000 | Under Constr. | Mid 1958 | Parsons | Parsons & Heurtey; Soc. Chimique | Soc. Chimique |
| | | *Desulfurization II | 175 Mmcf | ..... | Engineering | 1959 | ..... | Foster Wheeler Soc. Chimique | Foster Wheeler Soc. Chimique |
| | | *Distillation Recovery II | 112 Mmcf | ..... | Engineering | 1959 | ..... | Hydrocarbon; Lummus | Hydrocarbon; Lummus |
| | | Sulfur Recovery Phase II | 1,720 tons | ..... | Under Constr. | 1958 | Parsons | Parsons, Heurtey, Soc. Chimique de la Grande Pareisse | Parsons, Heurtey, Soc. Chimique de la Grande Pareisse |
| | | Sulfur Recovery Phase III | ..... | ..... | Engineering | 1959 | ..... | | |
| **East Germany** | | | | | | | | | |
| Ministry of Coal & Energy | Rostock | Catalytic Oil Gasification | 2.4 mm cfd | ..... | Under Constr. | End 1958 | ..... | Power-Gas Didier | Power-Gas; Didier |
| **West Germany** | | | | | | | | | |
| Badische Anilin und Soda Fabrik A G | Ludwigshafen | Polyethylene | ..... | ..... | Licensed | ..... | Phillips | ..... | ..... |
| Bune Werke Huels G.m.b.H. | Marl, Kreis Recklinghausen | Synthetic Rubber Plt. | 45,000 tons/yr. | $37,000,000 | Under Constr. | Summer 1958 | Esso; R&E Houdry; Firestone | Staff | Staff |
| Deutsche Erdol | Heide/Holstein | Propane-Propylene Separation | 7,000 tons/yr. Propylene | ..... | Under Constr. | 3rd Qtr., 1958 | Calif. Res. Hydrocarbon | Hydrocarbon, Hydro M | Staff |
| Deutsche Shell | Harburg | Crude Distiller | 40,000 bbls. | ..... | Projected | 1st Qtr., 1959 | ..... | ..... | ..... |
| | | Cat. Reformer | | | | | | | |
| | | Hydrodesulfurization | | | | | | | |
| | | *Platformer | 6,700 bbls. | ..... | Under Constr. | Summer 1958 | UOP | UOP Procon | Procon |
| | Godorf | Refinery | 80,000 bbls. | ..... | Planning | 1960 | ..... | ..... | ..... |
| Esso A. G. | Cologne | Refinery | 72,000 bbls. | $39,000,000 | Engineering | Jan., 1959 | Esso | | Braun & Others |
| | | Atmospheric Crude Distill. | ..... | ..... | ..... | ..... | ..... | Braun, Uhde, Lurgi | ..... |
| | | Powerformer | 9,000 bbls. | ..... | ..... | ..... | ..... | G.H.H. | ..... |
| | | Gas-Oil Hydrofiner | 12,000 bbls. | ..... | ..... | ..... | ..... | Kocha Still | ..... |
| | | Steam Cracker | 5,600 bbls. | ..... | ..... | ..... | ..... | | ..... |
| | | Sulfur Recovery | 8,900 tons/yr. | ..... | ..... | ..... | ..... | | ..... |
| Farbenfabriken Bayer A. G. | Dormagen | Crude Oil Cracking Plt. | ..... | ..... | ..... | Fall 1958 | Lurgi | ..... | ..... |
| | | Ethylene Oxide | 26 MM lbs./yr. | ..... | Under Constr. | 1958 | Scientific Design | Scientific Design | ..... |
| Farbwerke Hoechst AG | Hoechst | *Acetaldehyde | 11,000 tons/ yr. | ..... | Planning | ..... | Uhde | ..... | Uhde |
| Feldmuhle | Luisdorf | Ethylene | 10,000 tons/yr. | ..... | Engineering | End 1958 | ..... | Hydrocarbon Hydro M | Hydro M |
| Getty Oil Gesellschaft | Rees, Germany | *Refinery | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Kohle-Oil Chemie | Gelsenkirchen | Polyethylene | 24,000 tons/yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| Mobil Oil A. G. | Bremen Oslebhausen | Crude Two Stage | 16,000 bbls. | ..... | Under Constr. | 2nd Qtr., 1958 | ..... | Hydrocarbon Hydro M | Hydro M |
| Purfina Mineralol-raffinerie A. G. | Duisburg | Topping, Platformer Hydrodesulfurizer | 20,600 bbls. | ..... | Under Constr. | July, 1959 | UOP, Shell | Lummus; Uhde | Lummus; Uhde |
| Rheinische Olefinwerke G.m.b.H. | Bez. Köln Wesseling | Polyethylene Plt. | 2,000 tons/yr. | $33,000,000 | ..... | 2nd Qtr., 1958 | Shell | ..... | ..... |
| **Ireland** | | | | | | | | | |
| Irish Refining Co. | Whitegate | Refinery | 32,000 bbls. | $33,600,000 | Approved | 1959 | ..... | ..... | ..... |
| Esso Petr. (Ireland) | | | | | | | | | |
| Caltex (Ireland) | | | | | | | | | |
| Shell Mex., B.P. | | | | | | | | | |
| **Italy** | | | | | | | | | |
| Asienda Nazionale Idrogenasione Combustibil | Ravenna | Styrene Monomer Plt. | 14,000 tons/yr. | ..... | Engineering | ..... | Koppers | SBA | SBA |
| | | Butadiene Plt. | 20,000 tons yr. | ..... | Engineering | ..... | Houdry | ..... | ..... |
| Destillerie Italiane | Milano | Butanol | 11,000 tons/yr. | ..... | Engineering | ..... | Hoechst | Uhde | Uhde |
| Golfo Industria Petrolifera, A.P.A. | Gaeta | New Refinery | 15,000 bbls. | ..... | ..... | ..... | ..... | Tecnider | ..... |
| Isiom | Palermo | Refinery | 15,000 bbls. | ..... | Planning | 1958 | ..... | Staff | ..... |
| Mobil Oil Italiana S. p. a | Naples | Cat. Reforming | 9,000 bbls. | ..... | Under Constr. | Oct., 1958 | ..... | CTIP | CTIP |
| | | Cat. Hydrodesulfurization | 10,000 bbls. | ..... | Under Constr. | Oct., 1958 | ..... | CTIP | CTIP |
| | | Lube Expansion | ..... | ..... | Under Constr. | Oct., 1958 | ..... | Staff | Staff |
| Shell Italiana | Palermo | Refinery | 20,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| Sincat | Priolo, Sicily | Ammonia Unit | 150 tons | ..... | ..... | ..... | ..... | Foster Wheeler | Foster Wheeler |
| Soc. Solvay & Cie | Italy | Polyethylene | ..... | ..... | Licensed | ..... | Phillips | ..... | ..... |
| STANIC Industria Petrolifera | Livorno | Hydrofiner I | 8,200 bbls. | $1,600,000 | Engineering | June, 1958 | Esso | CTIP | CTIP |
| | | Hydrofiner II | 8,200 bbls. | $1,600,000 | Engineering | Sept., 1958 | Esso | CTIP | CTIP |
| **Netherlands** | | | | | | | | | |
| B. F. Goodrich & Algemene | Arnheim | *Butadiene | ..... | ..... | ..... | Mid 1959 | ..... | ..... | ..... |
| Kunststijde Unie N.V. | ..... | Styrene Plant | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Esso Nederland | Rotterdam | Refinery | 100,000 bbls. | $50,000,000 | Under Constr. | Early 1960 | Esso | Esso | Badger, Comprimo N.V. |
| Mekog | Velsen-Ymuiden | Nitrogen Fertilizer | ..... | $9,000,000 | Planning | ..... | ..... | ..... | ..... |
| Nederlandsche Dow Maatschappij N.V. | Rotterdam | Processing Plt. | ..... | ..... | Planned | ..... | ..... | ..... | ..... |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 248*

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| N. V. de Bataafsche Pet. Maatschappij | Pernis | Cat. Reformer | 12,700 bbls. | ..... | Under Constr. | 2nd Qtr., 1958 | ..... | ..... | ..... |
| | | Hydrodesulfuriser I | 16,400 bbls. | ..... | Under Constr. | 2nd Qtr., 1958 | ..... | ..... | ..... |
| | | Hydrodesulfuriser II | 7,800 bbls. | ..... | Under Constr. | 2nd Qtr., 1958 | ..... | ..... | ..... |
| | | Alkylation Plt. | 2,800 bbls. | ..... | Complete | ..... | ..... | ..... | ..... |
| **Norway** | | | | | | | | | |
| Norsk Braendselolje | Oslo Fjord | *Refinery | 40,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| Standard (N.J.) | Oslo Fjord | Refinery | 40,000 bbls. | $30,715,000 | Engineering | ..... | ..... | Badger, N.V. | Badger, N.V. |
| **Portugal** | | | | | | | | | |
| Ammoniaco Portugues | Esterreja | *Ammonia | 40 tons | ..... | Under Constr. | 1958 | Uhde | Uhde | Uhde |
| **Portuguese W. Africa** | | | | | | | | | |
| Petrofina | Luanda | Refinery | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| **Scotland** | | | | | | | | | |
| British Hydrocarbon Chemicals | Grangemouth | Polyethylene Plt. | 25,000,000 lbs./yr. | ..... | Under Constr. | Early 1959 | Phillips | S&W; E. B. Badger, Ltd. | ..... |
| | | *Cumene Plt. | ..... | ..... | Engineering | Mid 1959 | Mid-Centry Corp. | Scientific Design | ..... |
| | | *Phenol | ..... | ..... | Engineering | 1959 | Distillates Ltd. | S & W | ..... |
| British Petroleum | Grangemouth | Copper Chloride Unit | 2,000 bbls. | ..... | Under Constr. | Late 1958 | ..... | Power-Gas | Power-Gas |
| | | Kerosine Treating | 2,000 bbls. | ..... | Under Constr. | Late 1958 | ..... | Power-Gas | Power-Gas |
| | | Deethaniser | 2,000 bbls. | ..... | Under Constr. | Late 1958 | ..... | Power-Gas | Power-Gas |
| Union Carbide, Ltd. | Grangemouth | Polyethylene Plt. | ..... | ..... | Under Constr. | ..... | ..... | George Wimpey & Co., Ltd. | George Wimpey & Co., Ltd. |
| **Spain** | | | | | | | | | |
| Hidro Nitro Espanola | Monzon | Ammonia Synthesis | 22 tons | ..... | Under Constr. | Mid 1958 | ..... | Uhde | Uhde |
| Refineria de Petroleos de Escombreras S.A | Escombreras | | | | | | | | |
| **Sweden** | | | | | | | | | |
| A. Johnson & Co. | Sweden | Refinery Exp. | ..... | ..... | ..... | ..... | ..... | Bechtel | Bechtel |
| Kooperative Foerbundet | Kvarntop | *Ammonia | 175 tons | ..... | Complete | ..... | Uhde | Uhde | Uhde |
| Stockholm Oil & Gas Works | Stockholm | *Cat Oil Gasification | 4 Mmcf | ..... | Under Constr. | Mid 1959 | Power Gas | ..... | ..... |
| **Turkey** | | | | | | | | | |
| Badische Anilin and Soda Fabrik | Kutahya | Ammonium Sulfate | 60,000 tons/yr. | | | | | | |
| | | Sulfuric, Nitric Acid | 50,000 tons /yr. | $20,000,000 | Under Constr. | 1958 | Badische Anilin & Soda-Fabrik AG | Badische Anilin & Soda-Fabrik AG. | ..... |
| Mobil Overseas, Shell, Cal-Tex, BP | Turkey | Refinery | 65,000 bbls. | $48,000,000 | Under Constr. | 1958 | ..... | ..... | ..... |
| Turkish Government. | Istanbul | Natural Gasoline Plt. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| **Union of South Africa** | | | | | | | | | |
| Standard-Vacuum | Durban | Refinery Exp. | 25,000 bbls. | $9,000,000 | Engineering | ..... | ..... | Foster Wheeler | Foster Wheeler |
| | | Powerformer | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Hydrofiner | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Steam Plt. | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Union Petrol Refinery Ltd. | Johannesburg | Refinery | ..... | $20,000,000 | Projected | ..... | ..... | ..... | ..... |
| **Yougoslavia** | | | | | | | | | |
| Yougoslav Government | Dubrovnik | Distill. and Treating | 1,350 bbls. | $1,350,000 | Planning | 1960 | ..... | Institute of Petroleum at Zegret | ..... |
| | Sisak | Topping and Stabilizing | 7,500 bbls. | ..... | Planning | 1961 | ..... | Institute of Petroleum at Zegret | ..... |
| | | Ammonia Plt. | 120 Tons | $15,000,000 | Planning | 1962 | ..... | ..... | ..... |
| | Pancevo | Ammonia Plt. | 250 Tons | ..... | Planning | 1962 | ..... | ..... | ..... |
| | Zagret | Reformer | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| **NEAR EAST** | | | | | | | | | |
| **Iran** | | | | | | | | | |
| National Iranian Oil Co. | Kermanshah | Refinery Exp. | 6,850 bbls. | $3,627,000 | Engineering | 1958 | NIOC | C.J.B. | ..... |
| **Iraq** | | | | | | | | | |
| Iraq Government | Baghdad | Refinery Exp. | 48,000 bbls. | $11,000,000 | Under Constr. | July, 1959 | Esso | Foster Wheeler | Foster Wheeler |
| | | Powerformer | 5,000, bbls. | ..... | ..... | Sept., 1959 | ..... | Foster Wheeler, Ltd. | Foster Wheeler, Ltd. |
| | | Kerosine Treating Unit | 5,000 bbls. | ..... | ..... | Sept., 1959 | ..... | Foster Wheeler | Foster Wheeler |
| | Qaiyarah | Refinery Revamp Crude Topping; Vacuum Distill.; Thermal Cracking; Asphalt | 7,500 bbls. | ..... | ..... | Late 1959 | ..... | ..... | ..... |
| **Israel** | | | | | | | | | |
| Fertilizers & Chemicals, Ltd. | Haifa Bay | *Ammonia Plt. Exp. Fertilizers | 50 tons | $5,000,000 | Engineering | 1959 | ..... | Staff Lurgi | Local |
| **Jordan** | | | | | | | | | |
| Jordanian Reconstruction Council | Mafrak | Refinery | ..... | $7,500,000 | Planned | ..... | ..... | ..... | ..... |
| **Kuwait** | | | | | | | | | |
| Kuwait Oil | Mina al Ahmadi | Two Distillation Units | 80,000 bbls. each | ..... | Complete | ..... | ..... | S&W; E. B. Badger; Bechtel | Bechtel |
| | | *Platformer | 4,070 bbls. | ..... | Engineering | Early 1959 | UOP | Procon-Bechtel | Procon-Bechtel |
| | | *Prefractionator | 7,200 bbls. | ..... | Engineering | Early 1959 | UOP | Procon | Procon |
| **Neutral Zone** | | | | | | | | | |
| Getty Oil Co. | Neutral Zone | Crude Stripping | 50,000 bbls. | $2,000,000 | Under Constr. | 1958 | ..... | Parsons | Parsons |
| **Syria** | | | | | | | | | |
| Syrian Government | Homs | Refinery | 20,000 bbls. | $11,000,000 | Planning | ..... | ..... | ..... | ..... |
| **FAR EAST** | | | | | | | | | |
| **Ceylon** | | | | | | | | | |
| Shell of Ceylon | Hendola | Refinery | ..... | $40,000,000 | Planning | ..... | ..... | ..... | ..... |
| **China** | | | | | | | | | |
| Hong Kong & China Gas Company | Hong Kong | Catalytic Oil Gasification | 1.5 mm cfd | ..... | Under Constr. | Autum 1958 | ..... | Power-Gas | Power-Gas |
| **India** | | | | | | | | | |
| Alkali & Chemical Corp. of India | India | Polyethylene Plt. | ..... | $6,300,000 | Under Constr. | 1959 | I. C. I. | ..... | Simon Carves, Ltd. |
| Indian Government | Bhavnagar | Refinery | 30,000 bbls. | $42,000,000 | Considering | ..... | ..... | ..... | ..... |
| New Central Jute Mills | Varaussi, Inda. | *Ammonia | 45 tons | ..... | Under Constr. | ..... | Uhde | Uhde | Uhde |
| **Japan** | | | | | | | | | |
| Befu Chemical | Befu Harbor Honshu | Ammonia Plt. | ..... | ..... | Under Constr. | ..... | Texaco | Chemico | Chemico |
| Daikyo Oil | Yokkaichi | Houdriformer | 3,000 bbls. | $2,200,000 | Complete | ..... | Houdry | Treco | Chiyoda |
| Furukawa Chemical Industries | Japan | Polyethylene | ..... | ..... | Approved | ..... | Phillips | ..... | ..... |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 250*

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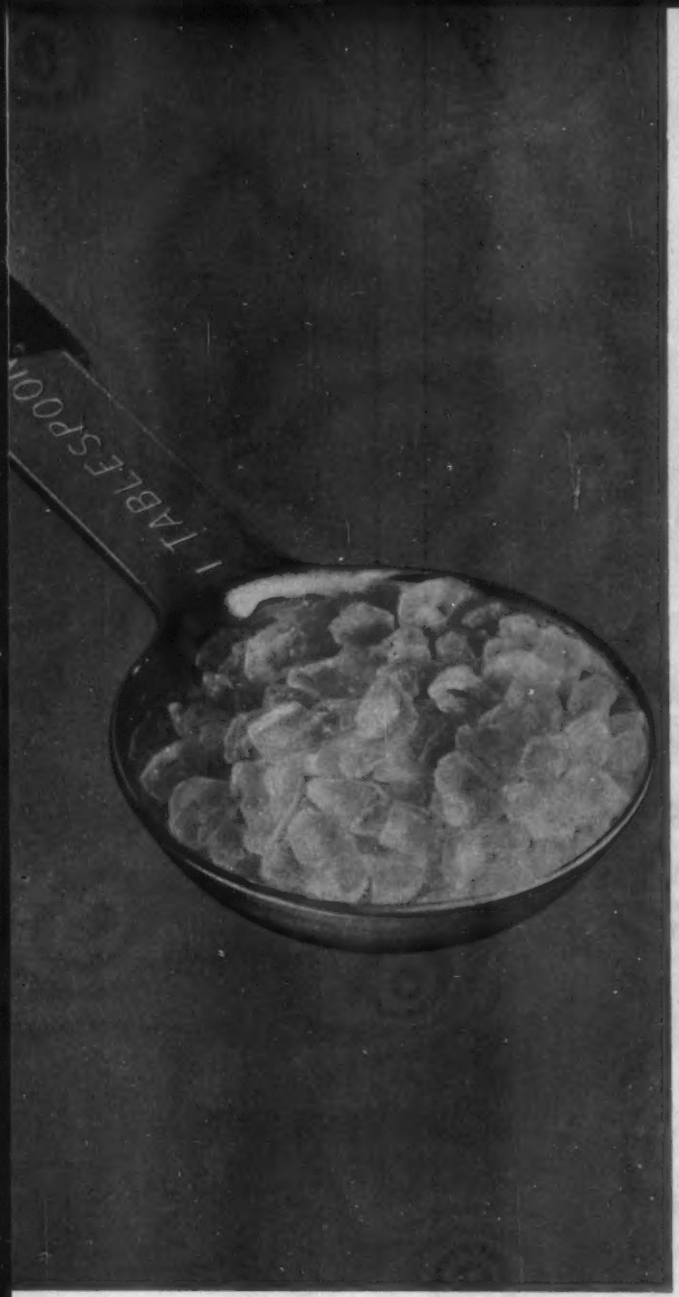
For more data on advertised products, use Readers' Service Cards, last page.

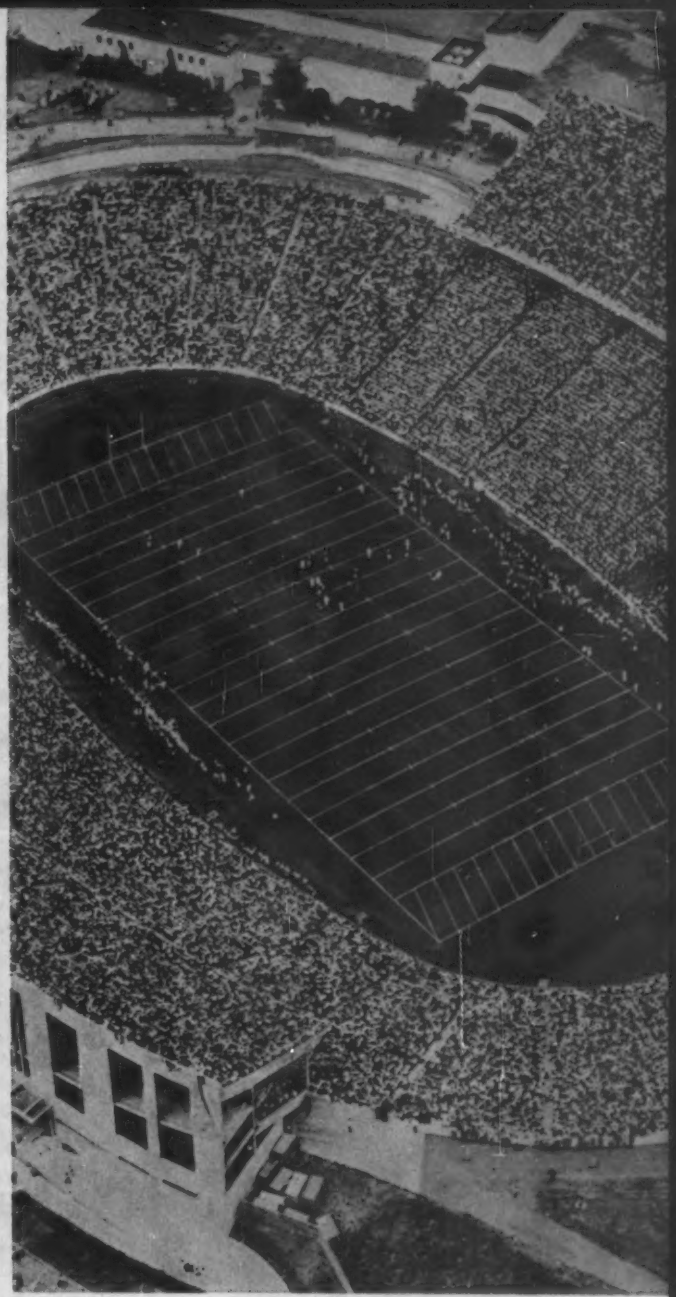
## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Idemitsu Kosan Co... | Tokuyama | Sulfur Recovery Plt. | 20 tons | ..... | Under Constr. | Mid 1958 | Girdler | Girdler, J.G.C. | J.G.C. |
| | | Unifiner | 6,000 bbls. | $370,000 | Engineering | Summer 1958 | UOP | UOP; J.G.C. | ..... |
| Koa Oil. ..... | Iwakuni | Cat. Reformer | 4,000 bbls. | ..... | Planning | Mid 1959 | ..... | ..... | ..... |
| Maruzen Oil Co..... | Osaka | Ethyl Ketone | 15 tons | $3,000,000 | Complete | ..... | ..... | Chemical Project Assoc. | Chiyoda |
| | | Secondary Butyl Alcohol | 15 tons | | | | | | |
| | Matsuyama | Udex Unit | 70 tons | $2,200,000 | Under Constr. | June, 1958 | UOP | UOP; Japan Gasoline Co. | J.G.C. |
| Mitsui Petrochemical Industries | Iwakuni City | Ethylene Oxide, Ethylene Glycol | 500 tons | $30,000,000 | Complete | ..... | Scientific Design | Scientific Design | ..... |
| | | Ethylene Unit | 1,670 tons | ..... | Complete | ..... | S&W | S&W | S&W |
| Mitsui Petrochemical Industries—(Cont'd) | Iwakuni City | Phenol Unit | 1,000 tons | ..... | Under Constr. | ..... | Distillers, Ltd. | S&W | S&W |
| | | Cumene Plt. | ..... | ..... | Complete | ..... | Scientific Design | Scientific Design | ..... |
| | | Udex Unit | 1,800 bbls. | ..... | Complete | ..... | UOP; Dow | UOP; J.G.C. | J.G.C. |
| | | Unifiner | 500 bbls. | ..... | Complete | ..... | UOP | UOP; J.G.C. | J.G.C. |
| | | *Terephthalic Acid | ..... | ..... | ..... | 1958 | Scientific Design | ..... | ..... |
| Mitsubishi Petrochemical Co. | Yokkaichi | Ethylene | 67.7 tons | ..... | Engineering | ..... | S&W | S&W, Japan Gasoline | Japan Gasoline |
| | | Styrene Monomer | 55.4 tons | ..... | Engineering | ..... | B.P.M. | B.P.M. | ..... |
| | | Polyethylene | 30.8 tons | $28,000,000 | Under Constr. | 1958 | BASF | BASF | ..... |
| | | Ethylene Oxide | 9.2 tons | ..... | Engineering | ..... | ..... | ..... | ..... |
| | | Ethylene Glycol | 9.2 tons | ..... | Engineering | ..... | ..... | ..... | ..... |
| Nihon Gas Nagaku Kogyo | Niigata | Urea | 95 tons | ..... | ..... | ..... | ..... | Chemico | Chemico |
| | | Ammonia | 100 tons | $2,100,000 | Engineering | ..... | ..... | Chemico | Chemico |
| | | Ammonia Sulfate | 200 tons | ..... | ..... | ..... | ..... | Chemico | Chemico |
| Nippon Oil Co..... | Niigata | Platformer | 1,600 bbls. | $1,500,000 | Engineering | 1958 | UOP | UOP; Japan Gasoline | Japan Gasoline |
| Nippon Petroleum Refining | Yokohama | Lube Oil Furfural Unit | 700 bbls. | $1,000,000 | Engineering | 1958 | Texaco | Chiyoda | Chiyoda |
| Nippon Petrochemicals | Kawasaki | Ethylene | 25,000 tons/yr. | $16,000,000 | Engineering | Spring, 1959 | S&W Esso | S&W; Japan Gasoline | Japan Gasoline |
| | | Butadiene | 5,000 tons/yr. | | | | | | |
| Showa Denko KK.. | Tokyo | *Synthesis Gas Plt. | 121 Short tons | ..... | ..... | ..... | Texaco | Foster Wheeler | Foster Wheeler |
| Showa Yokkaichi Sekiyu Co., Ltd. | Yokkaichi | Refinery | 40,000 bbls. | ..... | Under Constr. | May, 1958 | ..... | ..... | ..... |
| Showa Yuka..... | Japan | Polyethylene | ..... | ..... | Approved | ..... | Phillips | ..... | ..... |
| Sumitomo Chemical.. | Niihama | Ethylene Unit | 36.4 tons | ..... | Complete | ..... | S&W | S&W; Japan Gasoline | Japan Gasoline |
| Toa Nenryo Kogyo... | Shimizu | Ref. Exp. Powerformer; Hydrofiner; Kerosine Acid treating; Copper Sweetener; Offsite Facilities | 43,500 bbls. | $12,500,000 | Under Constr. | Late 1958 | ..... | ..... | ..... |
| **Korea** | | | | | | | | | |
| Korean Government.. | Chung-ju | Urea Plt. | 285 tons | $25,000,000 | Under Constr. | 1958 | Uhde | Hydrocarbon, McGraw, Vulcan | Hydrocarbon, McGraw |
| **Sumatra** | | | | | | | | | |
| Standard-Vacuum.... | Palembang | Cat. Cracker | 11,000 bbls. | $20,000,000 | Planning | ..... | ..... | ..... | ..... |
| | | Polymerization | 1,200 bbls. | | | | | | |
| | | Revamp Existing Plt. | ..... | | | | | | |
| **Taiwan (Formosa)** | | | | | | | | | |
| Chinese Petroleum Corp. | Kaohsiung | Alkylation Unit | 900 bbls. | $1,600,000 | Engineering | 1958 | Texaco | Badger | Staff |
| | | Sulfur Recovery Unit | 10 tons | $300,000 | Engineering | 1958 | ..... | Pintsch Bamag | Staff |
| **AUSTRALASIA** | | | | | | | | | |
| **Australia** | | | | | | | | | |
| Bitumen & Oil Refineries | Sydney | Diesel Unifiner | 2,500 bbls | ..... | Under Constr. | ..... | ..... | UOP | Staff |
| | | Crude Unit | 12,000 bbls. | ..... | Proposed | 1958 | ..... | Procon | Procon |
| BP Refinery (Kwinana) | Kwinana | Cat. Reformer | 10,000 bbls. | $8,000,000 | Under Constr. | End 1958 | ..... | UOP, Kellogg | Kellogg |
| Imperial Chemical Industries of Australia & New Zealand | Australia | Polyethylene Plt. | 3,500 tons/yr. | $5,040,000 | ..... | ..... | ..... | ..... | ..... |
| Shell Refining (Australia) | Clyde | Platformer | 6,700 bbls. | ..... | Under Constr. | 2nd Qtr., 1958 | UOP | ..... | Procon |
| | Geelong | Hydrodesulfuriser | 11,000 bbls. | ..... | Planned | 1st Qtr., 1959 | ..... | ..... | ..... |
| **Philippine Islands** | | | | | | | | | |
| Gulf Oil..... | Luzon | *Refinery | 10,000 bbls. | ..... | Planning | Late 1960 | ..... | ..... | ..... |
| Shell (Philippines).... | Manila | Refinery | ..... | ..... | Negotiating | ..... | ..... | ..... | ..... |
| Standard-Vacuum.... | Bataan | Refinery | 21,000 bbls. | $33,500,000 | Planning | ..... | ..... | ..... | ..... |

* First appearance in tabulation. † Added capacity.

**NOTE:**
Armistead—George Armistead & Co.
Atlantic—Atlantic Ref. Co.
Badger Mfg.—Badger Manufacturing Co.
Badger N. V.—Badger-Comprime N. V.
E. B. Badger Ltd.—E. B. Badger & Sons Ltd.
E. B. Badger Pty.—E. B. Badger & Sons Pty., Ltd.
Barnes—W. M. Barnes Co.
Bechtel—Bechtel Corp.
Beck—Henry C. Beck
Blaw-Knox—Blaw-Knox Co.
Braun—C. F. Braun Co.
Brown & Root—Brown & Root Construction Co.
Buckner—F. J. Buckner Corp.
Calif. Res.—California Research Corp.
Can. Kellogg—Canadian Kellogg Co.
Catalytic—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Ch. Pro.—Chemical Process, Inc.
C. B. & I.—Chicago Bridge & Iron Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd.
C. & I.—Chemical & Industrial Corp.
C. J. B. —Constructors John Brown, Ltd.
Consd. Eng.—Consolidated Engineering Company
C.T.I.P.—Compagnia Tecnica Industria Petroli
D & Z—Day & Zimmerman
Delta—Delta Engineering Corp.
Dresser—Dresser Engineering Corp.
Ebasco—Ebasco Services Inc.
E&A—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Edeleanu—Edeleanu Gesellschaft M. B. H.
Etabadger S.A.—Etablissement Badger, S.A.
Ferguson—H. K. Ferguson Co.
Fish—The Fish Engineering Corp.
Fluor—Fluor Corp.
Ford, Bacon, Davis—Ford Bacon & Davis Construction Corp.
Foster Wheeler—Foster Wheeler Corp.
Gas Plant Constr.—Gasoline Plant Const. Corp.
Girdler—Girdler Construction Division
Girdler (Canada)—Girdler Corp. of Canada, Ltd.
Graver—Graver Construction Co.
Grebe & Doremus—Grebe & Doremus Process Co.
Gutte-Hutte—Gutehoffnungshuette
Hedrick—Wyatt C. Hedrick Engineering Corp.
Hercules—Hercules Powder Co.
Hudson—Hudson Engineering Corp.
H&G—Humphreys & Glasgow, Ltd.
H.W.P.—Head Wrightson Process, Ltd.
Hydrocarbon—Hydrocarbon Research, Inc.
Hydro M—Hydrocarbon Mineraloel G.m.b.H.
Hydro E—Hydrocarbon Engineering S.A.R.L.
Kaiser—Kaiser Engineers
Kellogg—The M. W. Kellogg Co.
Kellogg P. A.—Kellogg Pan American
KIC—Kellogg International Corp.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Kidde Constr.—Walter Kidde Constructors, Inc.
Koch—Koch Engineering Company
Koppers—Koppers Co., Inc.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G.m.b.H.
Macco—Macco Corp.
McKee—Arthur G. McKee Co.
Olsen—O. L. Olsen
Parsons—The Ralph M. Parsons Co.
Pet. Comb. & Eng. Co.—Petroleum Combustion & Engineering Co.
Petreco—Petroleum Construction Co.
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
Russell—Russell Engineering Corp.
Rust—Rust Engr. Co.
SBA—Soc. Bodge do L'Azote et des Produits Chimiques du Marly
Scientific Design—Scientific Design Co.
Soc. Chimique—Societe Chimique de la Grande Paroisse
Southwestern—Southwestern Constr. Co.
Stearns-Roger—Stearns-Roger Mfg. Co.
S & W—Stone & Webster Engineering Corp., Chemical Division
S & W Canada Ltd.—Stone & Webster Canada Ltd.
Swco—Southwestern Engineering Co.
Tears—Tears Engineers
Tellepsen—Tellepsen Petro-Chem Constructors
Treco—Refinery Engineering Co.
Tuloma—Tuloma Builders
Uhde—Friedrich Uhde, G.m.b.H.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Engineering Div.



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# Technical Writing Isn't Easy, But . . .

**If you have a tough time writing reports; if sometimes you know what you want to say but just can't get it down on paper, then you're fighting the battle of words and facts. Here's how you can win.**

**W. A. Sylvester,** The Standard Oil Company (Ohio), Cleveland

VERY OFTEN engineers have a misguided humility about their writing. They overlook the fact that technical matters are hard to write about, no matter how literate one may be.

That is why "practical" advice about writing is not necessarily helpful. Even if such advice helps one engineer, it may not help another, who has equally complex but entirely different problems. An engineer can find his own practical solutions, if he understands the difficulties he faces, for the ability to put theory into practice is the essence of an engineer's professional training. Consequently, this brief sketch about the problems of technical reports will be unashamedly theoretical.

**Sometimes It's Easy.** Fortunately, engineers do not always have problems in preparing reports. We should understand why some reports are easy, so that we can see why others are difficult.

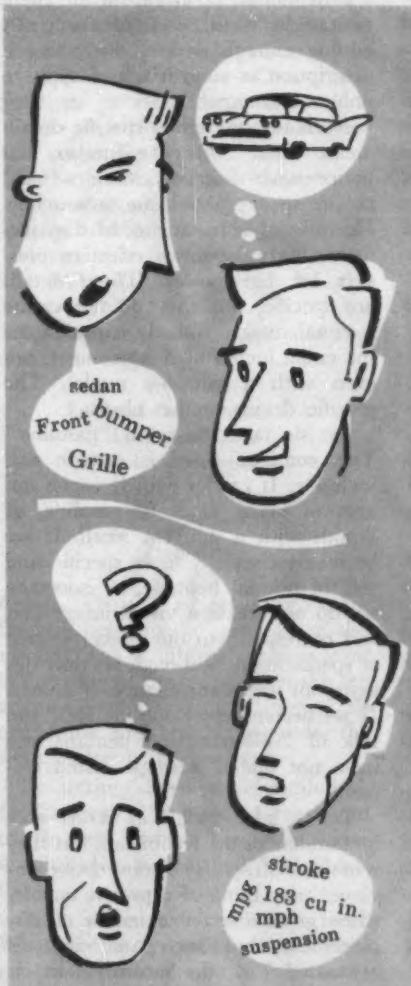
Engineers have little difficulty with the body of a straight-forward chronological account. One describes the stocks selected, the tests run, the data noted. The report may not be dramatic, but it is clear and orderly—exactly what it is supposed to be.

Nor does an engineer have difficulty in describing equipment. He starts at one end, describes the components as they appear spatially until they are all accounted for.

Neither does he have trouble in following a process—from the gasoline in the tank, through the lines, the filters, the carburetors, and so forth, to the exhaust.

If he wants to, he can completely reverse the pattern of these organizations. He can start with the exhaust and work back to the gasoline, or he can start at the other end of the equipment and describe the components in an entirely different direction.

These patterns—chronological, spatial, or functional—are easy to handle and easy to manipulate. They




**Suppose a layman is writing about an automobile; the word vaguely suggests a four-wheeled vehicle. Then he adds details—station wagon, turquoise, bent fender, up front, right, etc. Soon the details create a description so vivid it will apply to only one car.**

**But what happens when the engineer or technician talks of an automobile? He speaks of cubic inches of displacement, of brake mean effective pressure, of horsepower. The details are specific, but they do not create a visual image.**

**In the technical report, specific details tend to remain abstract—is there any wonder why we have difficulty?**

**"One can illustrate the 'meaning' of 2-2-4 trimethyl pentane by making an image with a tinker toy. Such models can he helpful, but they are just ways of explaining an essentially abstract concept."**

are relatively easy at least, because there is no conflict between language and technical matters. An arrangement in actual time, or space, or both, corresponds to an arrangement of words, and so the engineer can organize his report.

However, when he turns to the introduction or to the conclusion, even for a simple report, he can run into difficulty. Just *why* was the project started? Just *what* does it mean? The moment he has to say something *about* technical matters, he interrupts the pleasing one-to-one relationship between technical matters on the one hand, and words or symbols on the other.

**The Reader Intrudes.** "What is this all about . . . for me?" says the report reader who may be primarily interested in the feasibility of production, costs, or the "newness" of the project. He does not wish to go through every detail, and so the engineer must relegate some areas to footnotes or to appendixes. He must view the report from a different angle. He must cover some ground swiftly, and other ground in great detail.

He does this by using different kinds of words. Some words are inclusive, and cover a large area of meaning; these are generic words. Other words are narrow, and cover a small area of meaning; these are specific words. "Petroleum oil" is generic; Diesel fuel is specific. These words are generic and specific only in relationship to each other. "Petroleum oil" is no longer generic, but specific when compared to the word "liquid."

Words that are relatively generic not only cover ground swiftly, they also establish frameworks that define large areas of significance. In writing a summary of a report, one may wish to refer to "petroleum oil," diesel fuel, a kind of diesel fuel, or a specific property of diesel fuel, depending upon the reader's interest or technical background.

A distinction between generic and specific words will help us restate our work for the benefit of other people. Such distinctions will also help us to organize our reports; we will not jump back and forth between inclusive concepts and narrow ones. We will write in a consistent and orderly way.

**The Art of Creating Images.** We do not have much trouble organizing our writing about everyday matters. We can easily arrange our words into a consistent pattern from the generic to the specific, or the other way around. We can either make a general statement and back it up by details, or we can start with details and lead to a broad, general conclusion.

Suppose, for example that we are writing, as laymen, about automobiles. The word suggests vaguely a four-wheeled vehicle. We can then add details—a station wagon, turquoise, a bent fender, up front, on the right, white-side walls, and so forth. By adding enough details, we create a description so vivid it would apply to only one automobile.

Normally, therefore, specific details create vivid concrete images, but notice what happens when a technician speaks about an automobile. He talks of cubic inches of displacement, of brake mean effective pressure, of horsepower. These details are specific, but they do not create a visual image. Nobody can ever see the cubic inches of displacement, not even with a cutaway model. The specific details remain abstract.

Let us take the word "gasoline". This common word is generic and inclusive. It carries with it vague images of many kinds of gasoline, of liquids with a pungent smell. If we become technically more specific and talk of normal heptane, or isooctane we do not create a visual image that will correspond to our higher degree of specification (although we may imagine an irrelevant change of color). If we become more specific still, and talk of 2-2-4-trimethyl pentane, we have not added a single visual element.

To be sure, technical terms may be familiar to the technician, but they remain abstract. The automotive engineer may think of a precise engine, when given the cubic inches of displacement, but such an image is associated with the measurement; it is not the measurement. Likewise, one can illustrate the "meaning" of 2-2-4 trimethyl pentane by making an image with a tinker toy. Such models can be helpful, but they are just ways of explaining an essentially abstract concept. In technical matters, our visual referents are often related only indirectly to the fact.

In everyday usage, generic terms tend to be vague; specific terms, vivid and visual. When writing about technical matters, we find that specific terms remain abstract.

Consequently, when we write about technical matters, we are going against the normal tendency of the language. Small wonder we have difficulty.

Technical matters tend to be abstract; abstractions look alike; we have difficulty in distinguishing between the generic and the specific.

**Specific but Abstract.** The mind works more easily with physical images. Lacking any physical images to work with, the engineer is hard put to make distinctions which will help him sort his material.

Worse still, even when he can distinguish degrees of generalization technically, these degrees may not correspond to similar degrees in words. We can see this discrepancy best if we turn to mathematics.

Let us take a simple arithmetic statement: $3(2)^2$. We can say that this is less inclusive than the more general statement: $3(x)^2$. The algebraic statement includes $3(2)^2$ and many other arithmetic statements as well. Likewise, the statement $n(x)^{n-1}$ is more generalized still. Notice that it is more generalized mathematically. In actual practice, however, the arithmetic statement could control a vast number of details, such as the pricing of panels sold in thousands of colors and textures. The generic formula could be a minor detail about one particular rate of flow at one time. Put into words, the generic statement in mathematics, becomes specific.

The patterns of generalization in technical matters do not necessarily correspond to a pattern of generalization which is useful in a report.

**What Can be Done?** The engineer can ask himself some questions about

his data. Let us take a simple example. Suppose an engineer has to write a description of a newly developed solvent. His first sentence might be:

*"This high K. B., medium cut, aliphatic naphtha has a high flash."*

There is nothing wrong with this sentence (except that the engineer would put down the actual figures). It is easy to understand. To quibble about a single sentence would be pedantic, and is offered solely to save space. But even in so short an example we can see that the organization, if extended to the entire data sheet, would be:

Solvency—kauri butanol
Distillation range
Hydrocarbon content
Flash point

Throughout an entire report, the jumbled organization would be distressing. So suppose he were to write instead:

*"This naphtha is aliphatic, medium cut, with a high K. B. and a high flash."*

The progression form the generic to the specific is consistent. Extended to the entire report, the organization would be:

Hydrocarbon content
Distillation range
Solvency
Flash point

Hydrocarbon content is generic, flash point is specific.

"Naphtha" establishes an area, and "aliphatic" cuts it down. "Medium-cut" restricts it even more, in this context.

Technically speaking, the difference of generalization between "medium cut" and "aliphatic" is minute, if not impossible to see. As a matter of fact, one can get an equally consistent pattern, merely by changing the words:

*"Of the medium cut naphthas, this aliphatic . . ."*

The difference lies in the way the words are used.

Notice, however, that K. B. is *technically* more generic than flash point. The solvency includes more properties than the volatility of the light ends.

The K. B. value may be more *generic,* but it is not necessarily more *significant.*

Indeed, for many reports we would find the flash point of greatest importance and might wish to mention it first. The specific detail, the flash point, might easily have a general interest for many applications.

And so the engineer has three questions to ask:

1. Is there a verbal pattern of generalization?
2. Is there a technical pattern of generalization?
3. Is there a pattern of generalization that lies outside of the report? (The interest of the reader.)

We have then three areas, and two directions to go:

AREAS
Words or symbols
Technical facts
Reader's viewpoint

DIRECTION
Specific
Generic

**Areas.** There is no easy way to distinguish between the generic and the specific. The ability to do so is vital to one's life of the mind. To make the attempt is to find new interest in one's work, and possibly to render the work easier in the long run.

By jotting down some reminders, the engineer can possibly mark out rough areas (which for some reason or other seem to be called "ball parks" today).

What is the mathematical pattern? What is the verbal pattern? How generic is this datum? How many other data does it control or influence? Given this datum, will the reader have a general or a specific interest in it?

**Which Direction?** Suppose we can distinguish between the generic and the specific, what then? In which direction should we go?

Two rules of thumb may prove helpful: put specific abstractions first, when they are self-explanatory and cumulative, so that they lead to a new, and unfamiliar generalization. Put a general, explanatory framework first, if the specific abstractions are hard to understand.

In other words, whenever possible move from the familiar to the unfamiliar.

If the engineer can see the conflict between words and technical matters, more than likely he can often find his own answers. I wish that I could honestly say that he can always find his own answers.

**Sometimes A Consistent Report Is Impossible.** This is a fact and we must admit that sometimes nothing can be done. Sometimes the reader simply cannot have an easy report, because the subject matter is insuperably difficult.

We cannot change the structure of the English language at will. We can not alter the entire Geneva system for the convenience of a single report. We cannot alter reading habits.

Your reader, for example, may be used to reading a report in this way:

He sees a formula at the beginning of the report. He jumps to the end, to see if he is interested in the report at all. He goes back to the middle, to see what the formula is leading up to. He works back to the list of mu's, rho's and sigma's to see what they mean. He takes these, plugs them into the formula, and is ready to start.

If you put the significance first, he will be left staring at a strange formula on the last page, and will be irritated at the engineer for not putting the incomprehensible first, the comprehensible last.

If the engineer can reduce the number of these cases to a minimum, he will be much happier. Even when he comes upon an impossible case, he will do the best he can, and realize why he could do no better. That should save him emotional energy and time. As we said, many engineers have a far greater ability to write than they realize. # #


**About the Author**

**William Sylvester** is technical publications editor for Standard Oil Co. (Ohio). He has had experience in editing, writing, and consulting for bulletins, brochures, engineering reports, and technical articles. He received his B.A. degree from Columbia College in 1940, his M.A. degree from the University of Chicago in 1947, and a Ph.D. degree from the University of Minnesota in 1951. He is a member of the Society of Technical Writers and Editors.

**The Gulf Printing Company's recently completed addition added 93,000 square feet to office and printing areas. The new brown and buff tile building provides more than three acres of working space—the largest plant of its kind in the Southwest. By streamlining operations, the new plant makes it possible to speed up and improve service to Gulf Publishing subscribers.**

# $1 Million Investment in the Future

**. . . Expanding Gulf Publishing and Gulf Printing companies move into larger quarters . . .**

PUBLISHING COMPANIES grow in direct proportion to the service they provide. And subscriber acceptance is the yardstick used to measure their success.

Since you, the subscriber, have been the key factor in Gulf Publishing's growth for 41 years, it is only proper that we share with you on these pages outstanding examples of the progress your acceptance has created. First of all, you have been directly responsible for the rapid circulation growth of PETROLEUM REFINER, WORLD OIL and PIPE LINE INDUSTRY magazines. During the past five years, Gulf's subscription lists have increased 52.8 percent —from 33,500 to more than 51,000— the largest circulation of any oil industry publisher.

This indication of reader acceptance has made it possible for our three industrial publications to increase total advertising by 1,317 pages during the same period—the biggest increase of any publisher serving the oil industry. Last year, Gulf Publishing advertising sales set a new record—6,125 pages.

What's more, Gulf's bound equipment catalog files have greatly improved their service to those who buy and specify equipment and services. Since 1952, distribution of the composite catalogs serving drilling, production, pipe line and refining phases of the industry has increased 59 percent—from 17,130 to 27,212 recipients.

For these reasons—all examples of your faith in us—Gulf Publishing Company and Gulf Printing Company have made the following investments in the future:

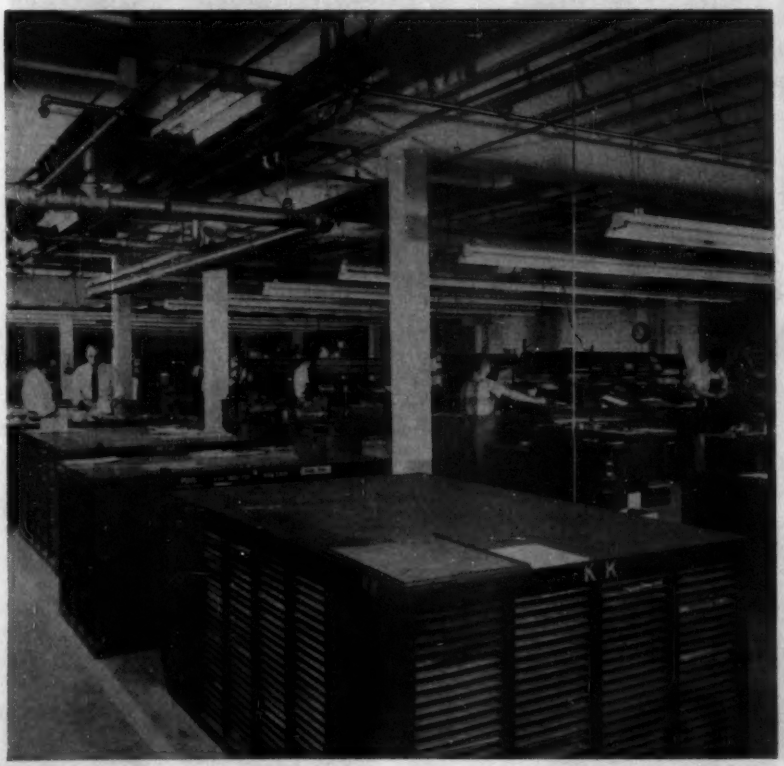
**Largest Printing Plant in the Southwest.** More than 93,000 square feet of working area has just been added to the Gulf Printing plant in Houston at a cost of more than $950,000. The new, ultra-modern addition gives the plant a total of 135,000 square feet of office and printing facilities, the largest plant of its kind in the Southwest. More than 75,000 square feet of the new addition is air conditioned with a 400-ton central unit.

The added plant and office space has improved efficiency of publishing operations, thus increasing subscriber

Until the new printing plant addition was opened earlier this year, the Gulf Publishing building had been the home of most of the printing facilities as well as publishing since 1928. The publishing building's interior has been completely remodeled in recent months. New improvements include relocation of the entrance, installation of new elevator, expansion of the library, plus addition of 11,200 square feet of badly needed space for the fast-growing publishing departments.

Gulf Publishing's oil library was recently expanded and reorganized. A popular source of oil industry information, the library is available to all who wish to make use of this company service. At left, WORLD OIL Editor Don Kliewer; center, WORLD OIL and PIPE LINE INDUSTRY Editorial Director Warren Baker; far right, PETROLEUM REFINER Editor George Gibbs.

Each of the five two-color letterpresses shown above can print 16 multi-color PETROLEUM REFINER pages at once. In addition, the plant has 11 small automatic letterpresses, 4 large one-color letterpresses, 3 small two-color letterpresses, 2 large two-color offset presses, 2 small one-color offset presses, and another large two-color letterpress.



Enlarged composing room working area, plus the addition of new equipment, have made it possible to speed up the printing of Gulf's industrial publications. More than $235,000 worth of new equipment has been installed since last November.

service to the maximum. All of the printing departments—sales, printing of telephone directories, printing of publications and catalogs, plate making, composing room and art department—are now under one roof at the West Dallas Street address.

**$250,000 Worth of New Equipment.** To improve speed and efficiency in the printing of Gulf's industrial publications, two new two-color presses and a one-color press have been added to the 23 letterpresses and three offset presses already in use.

New bindery, composing room and offset plate making equipment have been installed. And there is ample room left for future expansion.

**Expanded Publishing Facilities.** By moving the printing equipment to the new plant, much needed office space was added for the fast-growing publishing staff. In fact, 11,200 extra square feet were provided, for a total of 24,000 square feet of office space, an increase of 85 percent.

The publishing company entrance has been moved and remodeled. A new elevator has been added. The mailing room has been moved to larger quarters, greatly improving its efficiency.

The circulation, book, advertising and editorial departments are now working under one roof—in completely remodeled offices.

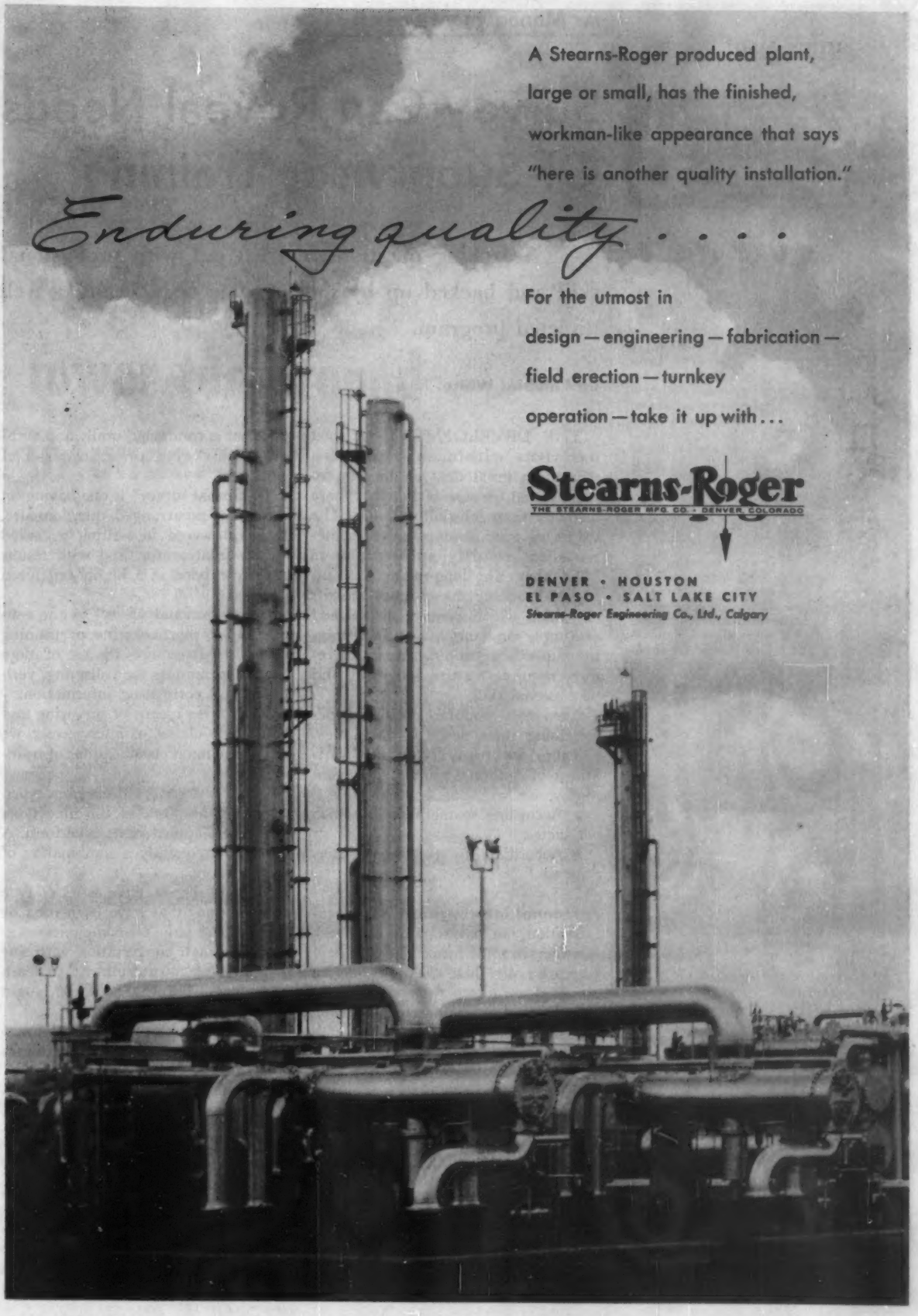
**New, Modern Library.** Customer use of Gulf Publishing library has increased so rapidly in recent years it is now being reorganized and enlarged. A new index system has been set up to improve customer service. And a large number of new oil publications are constantly being added.

Gulf's research facilities are available to all, readers and advertisers alike, who are seeking information about the oil industry.

GPC's operations also include publishing of technical petroleum books and oil industry stock forms. Further expansion of these departments is being planned.

These are but a few of our investments and plans for the future. Thus, by improving subscriber service, we hope to increase your acceptance of Gulf publications.

That will be the key to our future growth.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For the utmost in
design — engineering — fabrication —
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THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO
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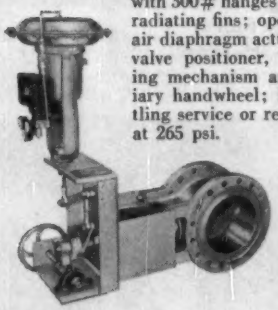
Your plant needs

ROCKWELL VALVES

*like these*

Standard heavy duty butterfly valve with Limitorque electric motor, declutching mechanism and handwheel for air, gases, water or other fluids.



Heavy duty butterfly valve with 300# flanges and heat-radiating fins; operated by air diaphragm actuator and valve positioner, declutching mechanism and auxiliary handwheel; for throttling service or recycle gas at 265 psi.

Heavy duty, wafer-type butterfly valve with worm gear and handwheel for high pressure and for high temperature service in pipe line flow control and shut-off of petroleum, gas or water.

*Rockwell valves for petroleum production, refining and pipe line service are designed in many types with manual or automatic control operators, in required metals, body linings and pipe sizes. Write for catalog.*

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2368 ELIOT STREET
FAIRFIELD, CONN.

As Management Sees It . . .

# Survey Can Reveal Needs Of Supervisor Training

**Searching questions, carried out with professional skill and backed up by mature judgment, insure a well directed program.**

**Carl Mullins White,** Tulsa

THE DEVELOPMENT of good supervisors within an organization depends a great deal on human relations, and because of this it is more involved than job-skill training. The values of good leadership are sometimes not readily apparent; quite often they are long-range and indirect. Probably the greatest benefits are those which cannot be weighed on simple monetary scales. Determining supervisor training needs, therefore, requires mature judgment and professional skill.

The most popular means of determining these needs is the survey.

There are many types and variations of training surveys. For simplicity, we will classify them:

- According to methods by which conducted
- According to personnel interrogated

**Personnel Interrogated.** To get information, an investigator must ask questions in some form. The people of whom he asks these questions may be classified as:

a. Prospective trainees (in this case, supervisors)
b. Prospective trainees' superiors
c. Prospective trainees' subordinates

**Methods** of conducting surveys could be classified as:

1. Informal
2. Formal
3. Professional

Since we are dealing in vague and relative terms, we might do well to agree on some definitions for purposes of this discussion.

We will call an "informal survey" one that is conducted orally and without an elaborate, prearranged set of questions.

A "formal survey" is one having an elaborate, prearranged questionnaire, to be answered in writing or asked by the interrogator, and with results to be compiled in a highly organized manner.

A "professional survey" is one conducted by psychcologists or training specialists. It requires the use of more precise techniques for collecting, verifying, and correlating information.

With three means of surveying and with three classes of interviewees, we have nine main classifications of training surveys.

Table 1 describes these nine types.

Seldom does one of the nine types in Table 1 appear in its pure form. A survey is frequently a combination of two or more.

We will discuss three types of type combinations that have been used by some of the large oil companies:

**1b—Informal:** conversation with any level of management to learn what it believes should be taught to its employes.

**2ab—Formal:** non-professional interrogation of prospective trainees and their superiors.

**3c—Professional:** polling of his subordinates to determine what training a supervisor needs.

**1b, Informal Polling of Trainees' Superiors.** This is one of the easiest, safest, and most popular methods. It is, however, somewhat time consuming. The interrogator asks key personnel what training they consider needed and records and consolidates their replies. For instance, he might



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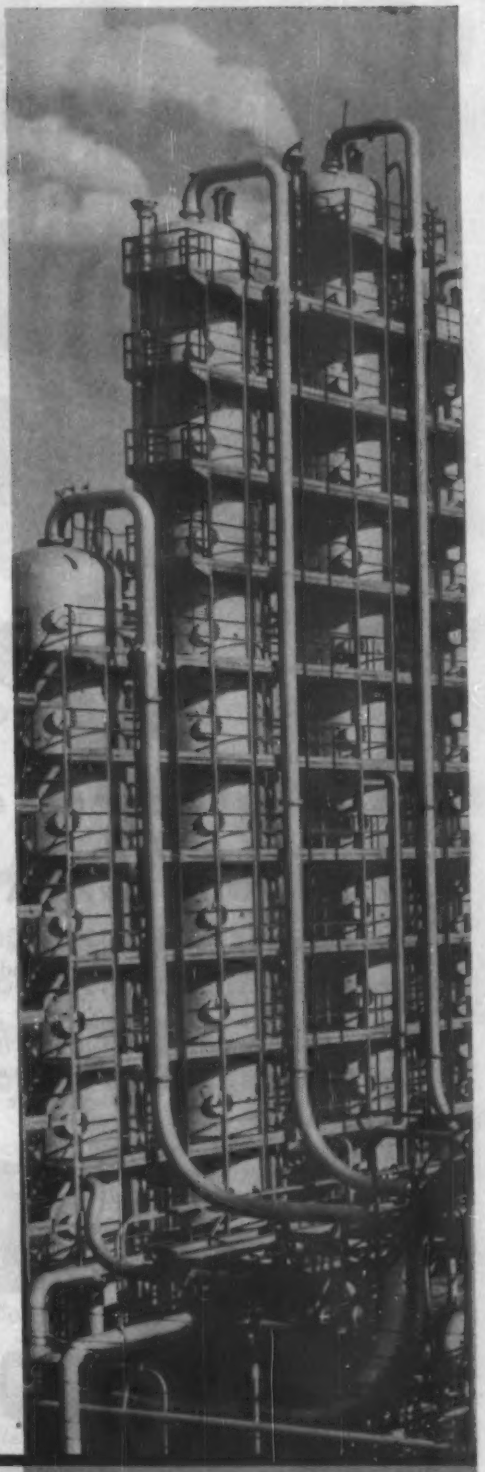
# Oakite ECP
engineered cleaning program

# races through tower turnaround in under a day



Steaming and washing a 90 foot tower just to remove gas normally took two to three days at one refinery. Labor crews then brushed and scraped for several more days to strip a heavy, crusty deposit from walls, pans, downcomers and 36 trays. Cost of manual labor alone exceeded $2,800.

But with an Oakite ECP, circulation cleaning of the tower was recommended. The refinery pumped a hot Oakite solution through the tower for 12 hours, followed up with 2½ hours of hot and then cold rinses. That did it. The tower was gas-free and completely clean. Cost of materials: only $500.

**WHAT IS OAKITE ECP?** It's an *Engineered Cleaning Program* that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by *materials* known to make short work of refinery soils, by proved *methods*. Send for booklets. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
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MATERIALS · METHODS · SERVICE
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*In our 50th year.*

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Oakite ECP
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"DEPENDABLE"
HEAT TRANSFER
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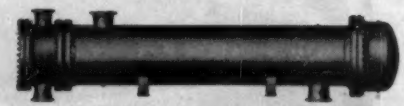
FOR GREATER ECONOMY
and
DIVERSIFIED APPLICATION

In the *modern and up-to-date* Doyle & Roth plants, we have *every means* of designing, developing and fabricating precision tubular products.

Our engineering department has met many *unusual problems* requiring extensive knowledge in the field of heat transfer engineering. *This "know-how" is available to you.*

D. & R. also passes on to you, the economies of its *standardization program.* Starting with engineering and following through on construction, *economies are substantial.*

Materials are purchased to *rigid specifications* and *standard components are stocked.*



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contact all major department heads and ask them to describe the training they would like their supervisors or section heads to receive. On the basis of their opinions, he makes training recommendations.

This method appears to place the responsibility for success or failure of a training project on responsible people. Thus it gains their support. Being oral and person-to-person, it may disclose attitudes not gathered in a formal (non-professional) questionnaire. One excellent plan is to use it as a supplement to a formal survey:

**2ab, Formal Survey of Prospective Trainees and Their Supervisors.** This survey often takes the form of a blanket questionnaire covering the whole range of possible supervisory training. Like the informal study, it says: "What training do you think is needed?" But it has prearranged questions or check lists to stimulate and organize the thinking of the interviewees.

**TABLE 1—Training Needs Surveys Classified According to People Interrogated and According to Methods by Which Conducted**

| Line | METHOD OF CONDUCTING | PERSONNEL SURVEYED | | |
|---|---|---|---|---|
| | | Column a Prospective Trainee | Column b Prospective Trainee's Supervisors | Column c Prospective Trainee's Subordinates |
| 1 | Informal..... | 1a | 1b | 1c |
| 2 | Formal..... | 2a | 2b | 2c |
| 3 | Professional..... | 3a | 3b | 3c |

1a—Informal, loosely planned, oral interviewing of prospective trainee to see what training he himself feels that he needs.
1b—Informal interviewing of prospective trainee's supervisors to see what training they feel should be given to him.
1c—Informal interviewing of prospective trainee's subordinates to see what training they feel should be given to him.
2a—Formal, highly, structured survey, with carefully planned questionnaire and tabulated findings, with information furnished by prospective trainee.
2b—Formal survey of prospective trainee's supervisors.
2c—Formal survey of prospective trainee's subordinates.
3a—Professional interrogation of prospective trainee.
3b—Professional interrogation of prospective trainee's supervisors.
3c—Professional interrogation of prospective trainee's subordinates.

Table 2 (Page 264) is an outline of a type used by some oil companies. This questionnaire is sent to each department head with a letter explaining that the company, "wants to know what training you consider needed by your supervisors." It is also sent to each supervisor with the statement that the company, "wants to know what training you feel that you need."

The questionnaire may include as many as a hundred items. Opposite each item is a blank for the respondent to check if he wants that item included. Some questionnaires carry


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another column of blanks in which the respondent writes "1," "2," "3," etc., to show his first 10 or 12 choices.

The idea of the survey (Table 2) is to help organize and encourage the thinking of responsible persons. Its value depends to a large extent on the thoroughness of the check list. A committee of well informed people may be asked to contribute items to it.

Table 3 (Page 265) is a shorter questionnaire of this (2ab) type. It too can be directed to prospective trainees and their superiors, but it specializes in a single field of interest. In this case it is concerned with "human behavior."

**3c, Professional Survey of Workers to Determine Supervisor Training Needs.** If the company does not have an industrial psychologist, this survey is conducted by an outside consultant or team.

In practice, the interrogators usually interview different levels of management as well as the employes. But here we will discuss only employe surveying techniques, especially the employe attitude survey.

Employe attitude surveys are designed to help management. . .

. . . see through the eyes of the workers how company policies, practices, and equipment could be improved.

. . . learn how employes could be motivated to greater achievements through improved supervision.

Through experimentation, psychol-

**About the Author**

**Carl M. White,** training representative for Service Pipe Line Co., has had an almost lifetime interest in the many phases of industrial training. He has a B.S. degree from Northwestern University, an M.A. degree in industrial psychology from the University of Tulsa, and has done graduate study at the University of Oxford, England. White has done extensive research in employe training practices in the petroleum industry. He is an educational advisor to the U. S. Air Force Reserve.


# PHILADELPHIA

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**Accuracy and low maintenance to meet fluid proportioning requirements in Chemical Processing, Refining and Boiler Feed Applications.**

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Models may be obtained to handle a great variety of "tough," corrosive and viscous materials. *Write for full information.*

**AMERICAN METER COMPANY**
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***High-Pressure Pumps • Controlled Capacity Pumps • Chemical Feed Systems***




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# PUMP CLINIC

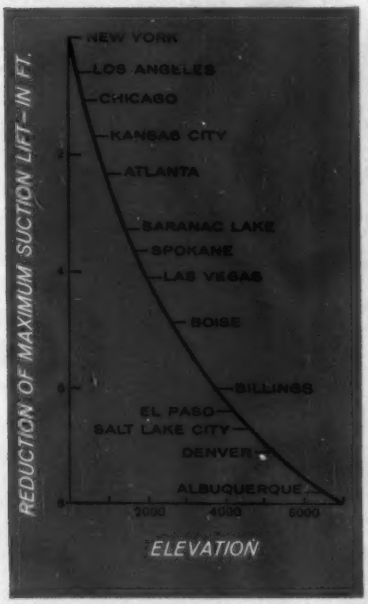
## altitude:

**ITS EFFECT ON SUCTION LIFT**

Atmospheric pressure — which causes liquids to flow into pump impellers—is reduced by about one inch of mercury for each 1,000 ft. of elevation. As a result, the maximum suction lift of any pump is correspondingly reduced if used in higher altitudes.

When buying a water pump, always specify *altitude* in addition to suction conditions. Your Worthington representative can then select a pump with the correct suction characteristic to operate properly at the required altitude.

This graph shows how suction lift is affected by altitudes of various U.S. cities.



*For more information on the effect of altitude on pump capacity—and other useful facts and figures on centrifugal pumps—send for our handy Centrifugal Pump Clinic folder. Write: Worthington Corporation, Section 21-1, Harrison, N. J.*

**WORTHINGTON**


**TABLE 2 – Questionnaire for**

| | * Check | # Choice |
|---|---|---|
| **A. PERSONNEL POLICIES AND PRACTICES** | | |
| 1. Interviewing | ____ | ____ |
| 2. Selecting employes | ____ | ____ |
| 3. Orientation of new employes | ____ | ____ |
| 4. Job analysis | ____ | ____ |
| —. | ____ | ____ |
| (This section goes on to include such items as procedure for handling all personnel actions, i.e., absences, promotions . . .) | | |
| x. Other | ____ | ____ |
| **B. COMPANY BENEFITS** | | |
| 1. Retirement | ____ | ____ |
| 2. Hospitalization | ____ | ____ |
| 3. Life insurance | ____ | ____ |
| 4. Vacations | ____ | ____ |
| —. (This section lists all benefit plans) | | |
| —. | ____ | ____ |
| —. | ____ | ____ |
| x. Other | ____ | ____ |
| **C. DEPARTMENTAL ORGANIZATION** | | |
| 1. Operating Department | | |
| a. How it is organized | ____ | ____ |
| b. Relationship to other departments | ____ | ____ |
| c. How it functions | ____ | ____ |
| (Follows a list of various facts about the department) | | |
| —. | ____ | ____ |
| —. | ____ | ____ |
| x. | ____ | ____ |
| 2. Accounting and Finance | | |
| a. How it is organized | ____ | ____ |
| b. Relationship to other departments | ____ | ____ |
| c. How it functions | ____ | ____ |
| —. | ____ | ____ |
| (List of items to be checked | | |
| —. | ____ | ____ |
| x. | ____ | ____ |
| 3. _____ Department | | |
| —. | ____ | ____ |
| (List continues until it covers every organizational phase of every department in the company.) | | |

ogists have improved the tools for measuring employe attitudes. They have developed techniques for eliminating ambiguous or irrelevant questions, and for interpreting the data collected. They often succeed in getting employes "to get it off their chests." Thus, trends of employe thinking are brought out which could not be learned by any other method.

Each of these three main types, informal, formal, and professional, has its place in a well rounded survey program. Informal surveys get certain slants not found in the others and helps insure support for the training project. The formal survey is an efficient means for gathering a

## Supervisor Training Needs

| | * Check | # Choice |
|---|---|---|
| **D. HUMAN RELATIONS** | | |
| 1. Securing employe cooperation | ____ | ____ |
| 2. The job of the supervisor | ____ | ____ |
| 3. Employes' problems | ____ | ____ |
| —. | ____ | ____ |
| —. | ____ | ____ |
| x. | ____ | ____ |
| **E. GENERAL** | | |
| 1. Our company and the community | ____ | ____ |
| 2. Principles of investment | ____ | ____ |
| 3. Money | ____ | ____ |
| 4. Governmental regulation | ____ | ____ |
| 5. The business cycle | ____ | ____ |
| —. | ____ | ____ |
| x. | ____ | ____ |

* Check —— items that interest you. # Show 1, 2, 3, your first ten choices.

| | | |
|---|---|---|
| **F. COMMUNICATION** | | |
| 1. Report writing | ____ | ____ |
| 2. Speaking | ____ | ____ |
| 3. Conference leadership | ____ | ____ |
| 4. Effective reading | ____ | ____ |
| —. | ____ | ____ |
| —. | ____ | ____ |
| x. Other | ____ | ____ |

List and explain on the blanks below any courses of instruction not listed above which you think should be offered.

_____

_____

_____

* Check items which you think should be offered.
# Check 1, 2, 3, your first ten choices.

## Table 3 – Questionnaire for Supervisor Training Needs---Human Relations

In the space provided, indicate 1, 2, 3, your order of preference.

—— Labor-management relations
—— Industrial psychology
—— Business English
—— Employe relations
—— How to read faster and better
—— How to remember
—— Effective speaking
—— Creative thinking
—— Conference leadership
—— Instructions methods & principles
—— Problems in supervision
—— Fundamentals of supervision
—— Effective writing

large amount of information quickly. Professional surveys provide the more precise measuring instruments needed for a well directed training program in human relations.

The next step is to analyze and organize the findings of all surveys and to prepare recommendations for training. These recommendations, when finally approved, are the foundation for detailed training plans.

Surveys have to be repeated from time to time to make sure that the training courses attain some portion of their desired goals, and to uncover need for further training. # #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**PALMER**
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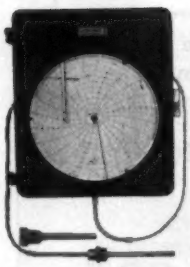

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

**INDUSTRIAL THERMOMETERS**

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

**RED-READING MERCURY LABORATORY THERMOMETERS**

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

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THERMOMETERS, INC.
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# If Oil Could Speak

*If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.*

*But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.*

*Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.*

*Read these facts. You will find them informative—and interesting.*

*Although the depletion allowance does not pertain to the refining industry, we think this information of sufficient interest to all oil men to warrant publication in* PETROLEUM REFINER.

**Is the Depletion Provision a Tax Gimmick?**

Not when oil companies face tremendous costs and gambles such as this:

Magnolia Petroleum Company and partners paid $4.30 an inch to drill nearly four miles of dry hole in Oklahoma last year.

Cost figures reveal that Magnolia and others paid $1,054,500 for the Sterba-Ordovician 1, 35-6n-10w, Caddo county, which was dry and abandoned at 20,426 feet.

This equals $51.62½ a foot, or $4.30 an inch, for an Oklahoma depth record. Results? Some geological information—nothing else.

Magnolia estimated that cost of the failure was equal to a year's depletion allowance on 780 average wells.

Of the total, only about $84,000 can be salvaged in casing and other equipment.

Magnolia, as operator, plugged back to about 14,000 feet after drilling to total depth, but after weeks of trying, failed to establish commercial production and the hole was plugged.

Magnolia said the well showed:

"(1) Deep wells are expensive.

"(2) It's a good thing we had other wells, because it would take the much-cussed depletion allowance off of about 780 average wells for a year to pay the cost of this one dry hole."

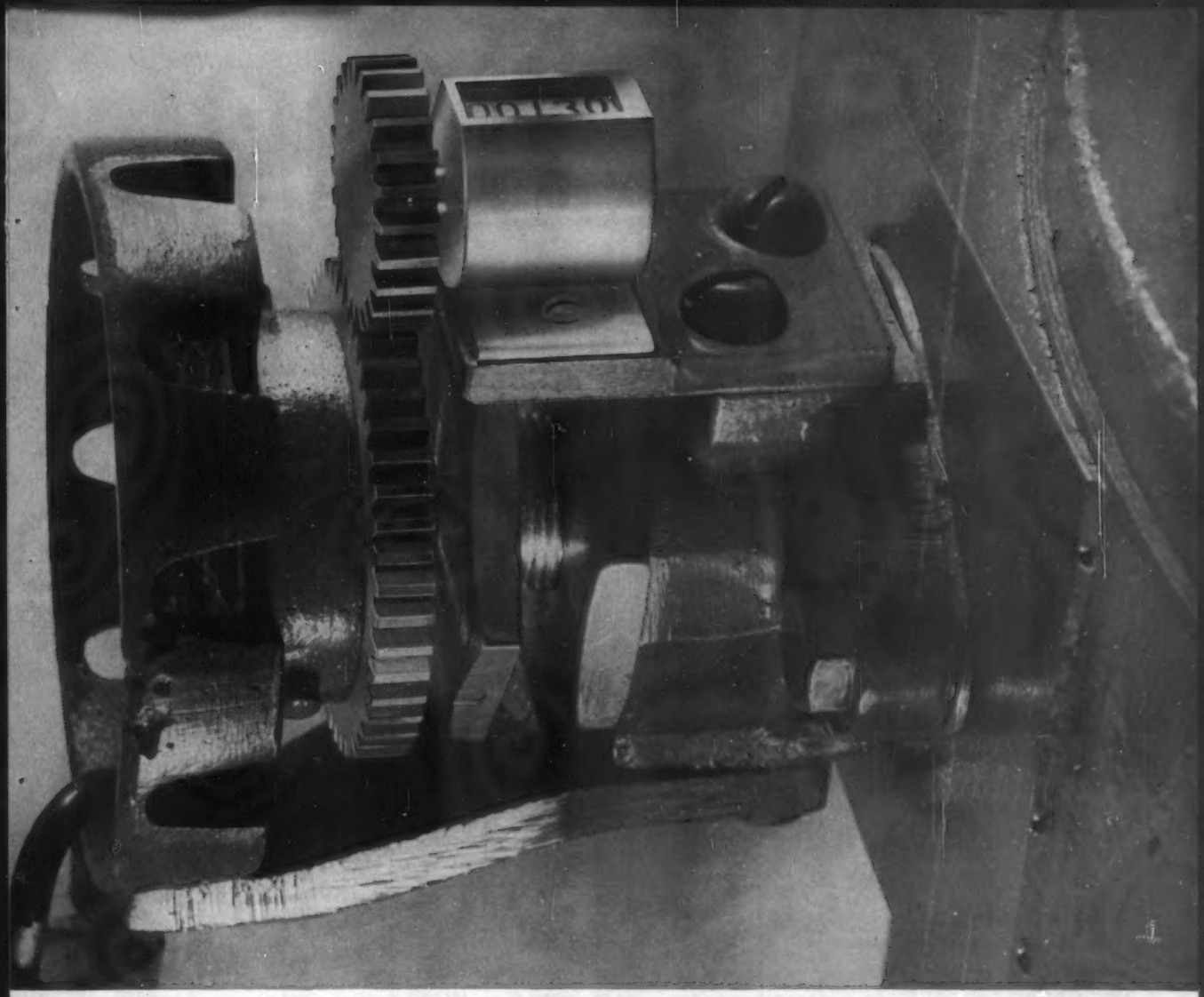
Magnolia, as operator of the joint wildcat venture, paid a little more than 40 percent of the total cost.

While drilling the Sterba 1 a pay zone was indicated in the Springer sand which was topped at 14,008 feet. A core taken from 14,334-353 feet contained 19 feet of sand with stain and odor, but no test was run at that time.

Crew then drilled on at the geological wildcat, with the Simpson as the target formation. A few weeks later the Sterba bypassed the old Oklahoma depth marker of 15,722 feet, set earlier in 1957 by British American Oil Producing Co.'s Reed 1, NE 30-2n-5w, a confirmation well to the Carter-Knox deep pool in Grady county.

When the 20,000-foot mark was reached, a log was run and crews continued to rotate while waiting for approval to drill to 24,500 feet. However, operations were stopped at the Oklahoma record of 20,426 feet.

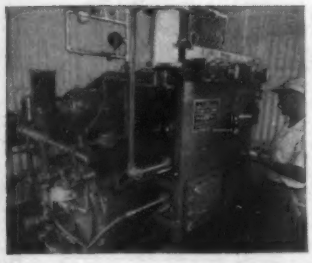
The hole was then plugged back to 14,463 feet in the Springer where production tests were run for several weeks, but nothing commercial was turned up.



*Air-Gas Ratio Valve*

## For precise control of inert gas quality . . .

# Come to Kemp



This Kemp Model 3-MIHE Inert Gas Generator provides up to 3,000 cu. ft. per hr. at Quaker State's Farmer's Valley, Pa. plant. Like all Kemp units, it maintains a steady supply at even pressure, regardless of line demands!

Only Kemp Inert Gas Generators have the famous Kemp Industrial Carburetor at the vital heart of the process. This carburetor, developed and patented by Kemp, gives exacting control to the generation of inert gasses. From mere pilot burner operation to full generator capacity, inert gas analysis is exact and constant, regardless of demands on the system.

Kemp-produced inerts are low-cost inerts. You can use them liberally, at a fraction of the cost of bottled gasses, for purging, blanketing, controlling reactions, agitation, or any of a hundred applications. You get better quality control and increased safety at the lowest possible operational cost.

For round-the-clock inert production with minimum maintenance, depend on Kemp Inert Gas Generators. Your Kemp Representative will suggest the proper model to fill your needs. Or write us direct for Bulletin I-10. The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

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Kemp Immersion Melting Pots

**KEMP**
**OF BALTIMORE**

Kemp Industrial Carburetors

Kemp Oriad Dryers

FOR CATALYTIC REFORMING

# 4 B&W Refractory Castables

## with low iron content

### B&W Kaocast

Ten years ago, B&W introduced this 3000° castable which offers a combination of high temperature use limit, as well as very low iron content. B&W Kaocast can either be gunned or cast in place.

### B&W Kaocrete-LI

After two years of extensive field service, B&W adds Kaocrete-LI to low iron content castables. B&W Kaocrete-LI, which has an iron content of less than 1%, has exceptionally high strength for resistance against abrasion and erosion. It has sufficient refractoriness for use at temperatures to 2700 F. Suitable for both gunning and casting.

### B&W Kaolite-LI

Another new castable with over two years of field service, B&W Kaolite-LI has high insulating properties due to its light weight (only 59 pounds per cubic foot). Its iron content is also less than 1%. It is designed to be applied with a cement gun only. Installation and maintenance time can be cut since Kaolite-LI does not require water curing and heat can be applied directly after gunning.

### B&W Kaocrete-32

Developed for special high temperature service, B&W Kaocrete-32 has extremely high strength and a use limit of 3200 F. It can be poured, plastered or gunned into place.

**Properties of B&W Low Iron Content Castables**

| | | B&W Kaocast | B&W Kaocrete LI | B&W Kaolite LI | B&W Kaocrete 32 |
|---|---|---|---|---|---|
| Use limit, °F | | 3000 | 2700 | 2300 | 3200 |
| Melting point, °F | | 3200 | 3100 | 2700 | 3297 |
| Average density lb/cu ft after firing | | 126 | 131 | 59 | 134 |
| Average % $Fe_2O_3$ | | 1.0 | 0.9 | 0.8 | 1.0 |
| Cold crushing strength—psi average—after heating for 5 hrs. at: | 1000 F | 700 | 2500 | 350 | 1000 |
| | 1500 F | 500 | 2500 | 350 | 800 |
| | 2000 F | 400 | 1200 | 300 | 750 |
| | 2200 F | 500 | 1300 | 450 | 1000 |
| | 2400 F | 500 | 1600 | — | 2000 |
| | 2600 F | 1000 | 6000 | — | 3000 |
| | 2800 F | 2200 | — | — | 3500 |
| | 3000 F | 3500 | — | — | 4000 |
| | 3200 F | — | — | — | 5000 |
| Permanent linear shrinkage—average % less than—after heating for 5 hrs. at: | 1000 F | 0.3 | 0.2 | 0.3 | 0.2 |
| | 1500 F | 0.3 | 0.2 | 0.4 | 0.2 |
| | 2000 F | 0.5 | 0.2 | 0.4 | 0.2 |
| | 2200 F | 0.5 | 0.2 | 0.6 | 0.4 |
| | 2400 F | 0.5 | +0.1 | — | 0.5 |
| | 2600 F | 0.5 | — | — | 0.5 |
| | 2800 F | 0.5 | — | — | 0.5 |
| | 3000 F | 0.3 | — | — | 0.2 |
| | 3200 F | — | — | — | 0.1 |

Consult your B&W Representative for additional information on these and other B&W Refractories for the refining industry.

**B&W REFRACTORIES PRODUCTS:** B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide

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WORKS: AUGUSTA, GA.

# What's Happening . . .

## . . . in the Industry

# Oil Company Earnings to Lag in 1958

### Chart below shows annual and fourth quarter net earnings of some oil companies, 1957 vs. 1956

(All "per share" data based on number of shares of common stock outstanding December 31, 1957.)

| COMPANY | ANNUAL EARNINGS | | | | | 4th QUARTER EARNINGS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total $Thousand | | $Per Share | | % Dif. | Total $Thousand | | $Per Share | | % Dif. |
| | 1957 | 1956 | 1957 | 1956 | | 1957 | 1956 | 1957 | 1956 | |
| Am. Maracaibo | 3,094 | 2,565 | .84 | .69 | +21 | 448 | 528 | .12 | .14 | — 15 |
| Andreon-Prich. | 5,243 | 5,880 | 2.93 | 3.41 | —11 | 1,168 | 1,651 | .65 | .92 | — 29 |
| Argo Oil | 4,921 | 4,509 | 2.51 | 2.30 | + 9 | 1,125 | 1,100 | .57 | .56 | + 2 |
| Ark. Fuel | 8,636 | 7,525 | 2.27 | 1.98 | +15 | 2,718 | 1,779 | .71 | .47 | + 53 |
| Ashland O & R. | 15,544 | 14,234 | 2.39 | 2.19 | + 9 | 3,575 | 4,250 | .55 | .65 | — 16 |
| Atlantic Ref. | 35,700 | 47,157 | 3.97 | 5.25 | —24 | 6,406 | 14,466 | .71 | 1.61 | — 56 |
| Aztec O & G. | 1,003 | 626 | .44 | .27 | +60 | 283 | 239 | .12 | .15 | — 18 |
| Bishop Oil | 267 | 418 | .47 | .78 | —39 | 105 | 130 | .18 | .23 | — 19 |
| Champlin | 9,704 | 9,479 | 2.28 | 2.23 | + 2 | 2,455 | 2,737 | .58 | .65 | — 10 |
| Cities Service | 59,179 | 62,152 | 5.63 | 5.91 | — 5 | 13,523 | 18,660 | 1.29 | 1.77 | — 27 |
| Clark O & R. | 1,422 | 2,486 | 1.07 | 1.81 | —43 | 338 | 465 | .25 | .35 | — 27 |
| Continental | 46,724 | 51,817 | 2.38 | 2.64 | —10 | 11,862 | 12,675 | .60 | .65 | — 7 |
| ‡Gulf Oil | 354,284 | 282,658 | 11.38 | 9.08 | +25 | 102,263 | 68,629 | 3.28 | 2.20 | + 49 |
| Honolulu Oil | 14,538 | 13,816 | 3.88 | 3.68 | + 5 | 3,247 | 3,228 | .87 | .86 | + 1 |
| *Humble O & R. | 175,900 | 178,961 | 2.45 | 2.49 | — 2 | †68,112 | †86,601 | †.95 | †1.21 | †— 21 |
| *Imperial Oil | 72,000 | 69,099 | 2.29 | 2.20 | + 4 | 13,579 | 17,961 | .43 | .57 | — 24 |
| *Intrnatl Pet. | 41,100 | 38,247 | 2.83 | 2.63 | + 8 | 10,000 | 9,547 | .69 | .66 | + 5 |
| Midwest Oil | 6,755 | 6,559 | 2.66 | 2.58 | + 3 | 1,568 | 1,556 | .62 | .61 | + 1 |
| Ohio Oil Co. | 41,490 | 41,216 | 3.16 | 3.14 | + 1 | 9,483 | 10,920 | .72 | .83 | — 13 |
| Phillips Pet. | 96,209 | 95,203 | 2.80 | 2.77 | + 1 | 21,982 | 23,632 | .64 | .69 | — 7 |
| Plymouth Oil | 6,027 | 7,956 | 2.40 | 3.17 | —24 | 372 | 1,971 | .15 | .79 | — 81 |
| Pure Oil Co. | 35,524 | 36,560 | 4.13 | 4.25 | — 3 | 9,377 | 10,350 | 1.09 | 1.20 | — 10 |
| Quaker State | 1,983 | 1,975 | 2.40 | 2.39 | + 1 | 392 | 307 | .48 | .37 | + 28 |
| Richfield Oil | 28,176 | 26,574 | 7.04 | 6.64 | + 6 | 6,402 | 5,805 | 1.60 | 1.45 | + 10 |
| Seaboard Oil | 11,159 | 9,369 | 3.05 | 2.56 | +19 | 2,431 | 1,839 | .66 | .50 | + 32 |
| Shell Oil Co. | 135,085 | 135,848 | 4.46 | 4.49 | — 1 | 29,287 | 35,704 | .97 | 1.18 | — 18 |
| Signal O & G | 13,052 | 10,694 | 3.03 | 2.48 | +22 | 3,765 | 3,648 | .87 | .85 | + 3 |
| *Sinclair Venez. | 10,057 | 9,152 | 2.51 | 2.28 | +10 | 3,893 | 2,202 | .97 | .55 | + 77 |
| Skelly Oil | 36,785 | 34,093 | 6.49 | 5.93 | + 8 | 8,554 | 10,749 | 1.49 | 1.87 | — 20 |
| Socony Mobil | 220,000 | 249,504 | 4.62 | 5.25 | —12 | 37,000 | 66,504 | .78 | 1.40 | — 44 |
| Standard, Cal. | 288,230 | 267,891 | 4.56 | 4.24 | + 8 | 76,465 | 77,536 | 1.21 | 1.23 | — 1 |
| Standard, Ind. | 151,509 | 149,432 | 4.24 | 4.18 | + 1 | 37,637 | 34,441 | 1.05 | .96 | + 9 |
| Standard, Ky. | 12,626 | 12,478 | 4.85 | 4.79 | + 1 | 3,067 | 2,917 | 1.17 | 1.12 | + 5 |
| Standard, N. J. | 800,000 | 808,535 | 4.07 | 4.11 | — 1 | 140,000 | 205,535 | .71 | 1.04 | — 32 |
| ‡Standard, Ohio | 23,920 | 26,592 | 4.79 | 5.35 | —10 | 9,338 | 6,433 | 1.93 | 1.33 | + 45 |
| Sun Oil Co. | 47,492 | 56,160 | 4.17 | 4.93 | —15 | 8,478 | 16,363 | .74 | 1.44 | — 48 |
| ΣSunray Mid-Cont. | 56,400 | 45,310 | 3.04 | 2.40 | +25 | 11,400 | 13,910 | .61 | .75 | — 18 |
| Texas Gulf Prod. | 6,442 | 5,658 | 1.60 | 1.40 | +14 | 1,482 | 1,231 | .37 | .31 | + 20 |
| Texas PC & O. | 7,232 | 7,210 | 2.01 | 2.00 | + 1 | 1,717 | 1,704 | .48 | .47 | + 1 |
| The Texas Co. | 332,304 | 302,263 | 5.94 | 5.40 | +10 | 89,200 | 94,833 | 1.59 | 1.70 | — 6 |
| Union of Cal. | 38,236 | 34,241 | 4.95 | 4.44 | +12 | 10,560 | 8,133 | 1.37 | 1.05 | + 30 |
| Universal Consol. | 3,563 | 3,355 | 3.72 | 3.50 | +11 | 823 | 894 | .86 | .93 | — 8 |
| Wilcox Oil | 891 | 783 | 3.02 | 2.65 | +14 | 214 | 94 | .72 | .32 | +129 |
| Woodley Pet. | 3,290 | 2,233 | 4.17 | 2.83 | +47 | 744 | 692 | .94 | .87 | + 7 |
| *Total, 40 Companies | 2,964,639 | 2,883,034 | .... | .... | + 3 | 671,254 | 768,238 | .... | .... | — 13 |

* Humble, Imperial and International Pet. are excluded from totals, being included as affiliates of Standard (N.J.). Sinclair Venezuelan also is excluded from totals, being a Venezuelan affiliate of Sinclair Oil Corp.
† Latter half of year.
‡ Standard Ohio) earnings for year 1957 and fourth quarter of 1957 include non-recurring profit of $1,685,000 or 35 cents per share.
§ Gulf Oil Corp.'s earnings for year 1957 and 4th quarter of 1957 include non-recurring profit from sale of Texas Gulf Sulphur Co. stock, which was $30,685,701 (99 cents per share) before taxes.
Σ Sunray for year 1957 includes capital gain of $9 million, or 52 cents a common share.

OIL COMPANY earnings reflect the lagging of demand for petroleum products and the resultant curtailment of industry operations.

It probably will be next fall, at earliest, before reported earnings can appear favorable in year-to-year comparisons. In October and November the quarterly reports for the three months ending September 30, 1958, will be issued. They possibly may show earnings equaling or comparing favorably with those in the similar period of 1957.

It now appears possible that fourth quarter earnings of 1958 will exceed those of 1957. But it is doubtful that profits for the year 1958 will equal those of 1957.

It is to be expected that decreases from last year will be reported in July and August for the second quarter of 1958, because of lagging volumes of oils produced and sold.

Sharp declines in earnings, ranging possibly from 20 to 50 percent, and averaging maybe 30 percent, will be reported in April and May, when first quarter statements are issued. The results for the period must be compared with those in the highly profitable initial quarter of 1957.

For the first quarter of 1958, refining companies may show the largest decreases, producers the smallest, and integrated companies average declines. Markets for products have been weak. Crude prices have weakened only to limited extent, but volumes of crude produced have been low.

For the fourth quarter of 1957, 40 oil companies together reported 12.6 percent less profit than in the final quarter of 1956. (See table.) That large decrease reflected lagging domestic demand for oils, normal exports versus Suez crisis exports a year earlier, lower product and crude

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VALVES
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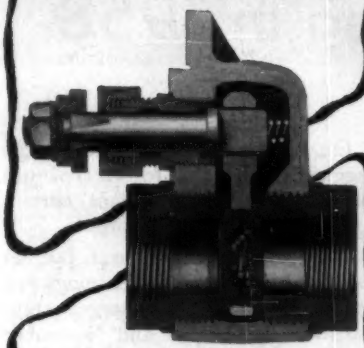

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## What's Happening. . .

prices, and higher operating costs.

In the third quarter of 1957, 52 oil companies reported earnings down 6.9 percent from 1956.

The decreases in earnings in the third and fourth quarters of 1957 largely canceled out the gains that were made in the first and second quarters. For the year 1957, 40 oil companies reported 2.8 percent more profit than in 1956.

For last year's first half 43 oil companies earned 17.0 percent more than in the initial half of 1956. Their second quarter profits were up 16 percent. First quarter profits were up 19 percent for 49 companies.

Although 40 companies together had a decrease of 12.6 percent in earnings in the fourth quarter of 1957, 17 showed increases. Prominent among the gainers were several West Coast and Middle West companies and a few crude producers. Fourth quarter profits were down moderately to sharply for a majority of the refiners and integrated companies.

**Estimate of U. S. Reserves**

| | BILLION BARRELS | | | Trillion Cu. Ft. |
|---|---|---|---|---|
| | Crude Oil | Natl. Gas Liquid | Total Liquid | Natural Gas |
| Reserves, End 1956 | 30.43 | 5.90 | 36.33 | 237.8 |
| Added Reserves, 1957 | 2.42 | 0.14 | 2.56 | 20.3 |
| Less Est. Production, 1957 | —2.55 | —0.35 | —2.90 | —11.5* |
| Reserves, End 1957 | 30.30 | 5.69 | 35.99 | 246.6 |
| Change in Reserves, 1957 | —0.13 | —0.21 | —0.34 | 8.8 |

* Production includes gas in underground storage but not gas used for cycling and pressure maintenance.

# API Reports on 1957 U.S. Oil Reserves

Proved reserves of natural gas in the United States climbed to an all-time high at the end of 1957. At the same time, however, the reserves of liquid hydrocarbons showed a net decline. These findings are reported jointly by committees of the American Petroleum Institute and the American Gas Association. A summary of their findings is shown in the accompanying table.

For the calendar year ending December 31, 1957, the Reserves Committee made the following estimates:

Crude Oil: At the end of 1956, the proven reserves of liquid hydrocarbons was 36.33 billion barrels. During 1957 revision of estimates, extension of old pools, and the discovery of new pools added 2.56 billion barrels to the reserves figure. However, production for this same period depleted the reserves by 2.90 billion barrels. Thus the net change in reserves was a loss of about 0.34 billion barrels. This is the first decline in reserves of liquid hydrocarbons since 1943.

Natural Gas: The production of natural gas for 1957 did not exceed the amount of new reserves. The net change in proven natural gas reserves then is 8.8 trillion cubic feet. The unit of volume is measured at 14.65 psia, and 60 F.

Canadian natural gas reserves were reported by the Canadian Petroleum Association. Their natural gas reserves climbed to 20.7 trillion cubic feet last year, compared with 19 trillion at the end of 1956. A net production of 0.28

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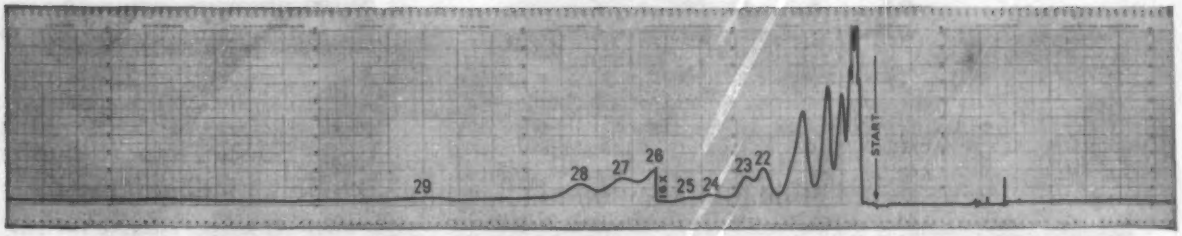
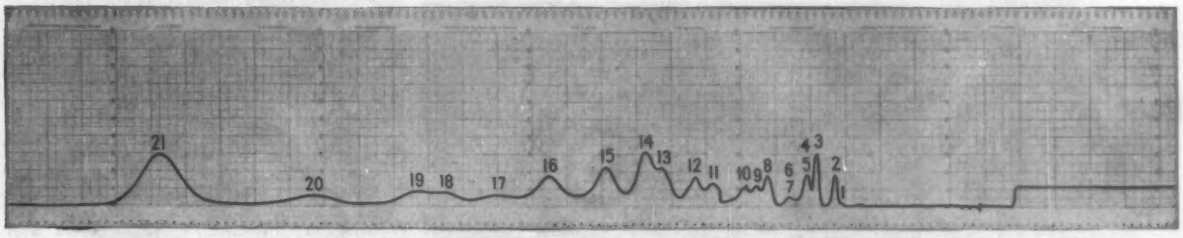
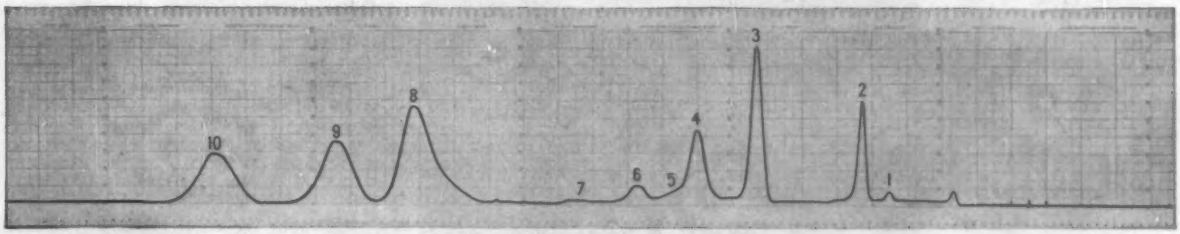



**ONE...** Gasoline containing 29 components passes through the first stage of the P-E Model 188 Triple Stage Vapor Fractometer. Low boiling components pass too quickly for analysis and are diverted to stage 2. Heavy ends (components 22-29) are resolved in characteristic bands.




**TWO...** Light ends are still too crowded for analysis and are passed on. Medium boilers (components 11-21) are well separated and are analyzed at this stage.




**THREE...** Light ends (components 1-10) come through clearly in the third stage. Total analysis time for all 29 components: 25 minutes from time analysis started!

*Perkin-Elmer's New Triple Stage Vapor Fractometer—*

# ANALYZES 29-COMPONENT GASOLINE SAMPLE IN LESS THAN 30 MINUTES!

The new Perkin-Elmer Model 188 Triple Stage Vapor Fractometer will analyze an unknown multi-component sample faster than any gas chromatography instrument in service today. The Model 188 eliminates tedious pre-separations and individual run-throughs for each set of components, thus offering considerable savings in time and efficiency over single stage instruments.

Analysis with the Model 188 is as simple as it is fast: The instrument cuts the sample three times, simultaneously analyzing high, medium and low boiling components, each under optimum chromatographic conditions. Each stage has its own recorder, and may be operated independently.

The Model 188 will analyze mixtures with components ranging from light gases to liquids boiling at 400°C. or higher, and can perform analyses not possible with conventional single stage instruments. The Model 188 is the latest in a series of gas chromatography instruments developed by Perkin-Elmer for the petroleum and chemical industries. For further information write us at 880 Main Avenue, Norwalk, Conn.

The P-E Model 188 Triple Stage Vapor Fractometer. Operator is shown introducing gas sample into second stage.

INSTRUMENT DIVISION
**Perkin-Elmer** *Corporation*
NORWALK, CONNECTICUT



For more data on advertised products, use Readers' Service Cards, last page.

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. . . with protecting Jackets of du Pont TEFLON, are impervious to chemical attack. Made with a variety of filler constructions to suit every connection problem—every pipe and nozzle material requirement—whether glass, ceramics, stainless, Karbate, Haveg, glass-lined steel, etc. That is why Garlock 8764 Chemiseal Gaskets have become the standard choice of the process industries. Catalog AD-154.

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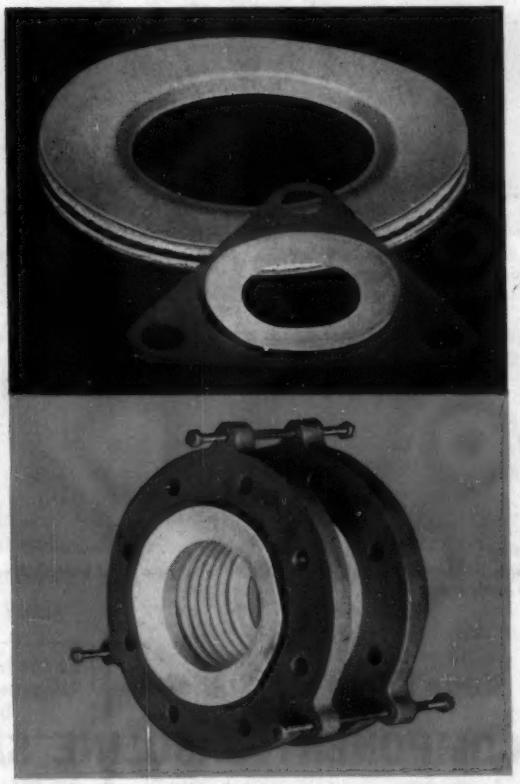

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## What's Happening. . .

trillion cubic feet was reported against reserves additions of 2.0 trillion cubic feet.

### Urges Special Import Quota For 'Small Independents'

George T. Goggin, executive vice president of Douglas Oil Co. of Calif., and newly re-elected president of the Independent Refiners Association of California, Inc., has urged the federal government to establish separate foreign crude oil import quotas for independent oil companies in California. Highlights of the proposed program of action for the Association for the coming year included:

- A recommendation to the U. S. Government that the small business, independent refiner should be allocated a quota of oil imports on a "total set-aside" formula. This would permit them to continue operations on a fair and competitive basis, as contemplated by Congress, and not on a basis related purely to the oil import quotas allocated to importing integrated, major oil companies. Such quotas to independent oil companies should allow those in the California district to have allocations of at least 60-70 percent of their respective thru-put refining capacity, with a minimum of at least 3000 bpd.

- Revision of the present set-aside program for the purchase by the Federal Government of petroleum products to permit independent refiners to participate on a "total set-aside" program in these purchases at a fair and reasonable market price.

- A strong recommendation to the major oil companies that they cut back production and refinery runs in sufficient quantities to absorb the present excessive inventories and thus help correct the catastrophic gasoline price war situation.

### Octanes Rise Again

Gasoline on sale at service stations in February rose to national weighted averages of 98.5 octane number for premium and 91.1 octane number for regular, according to the latest monthly survey of antiknock quality compiled by Ethyl Corporation.

Both averages gained 0.1 octane number over January. Compared with February 1957, the premium average was 1.2 octane numbers higher and the regular average was 0.7 octane higher.

For companies marketing more than one grade of premium, the survey showed a range of 100.5 to 102.8 octane number for the highest grade, on the basis of 40 samples in 20 cities.

Twenty-eight of the 57 cities in Ethyl's survey reported increases over January in the average octane number of their premium gasolines, five of them by 0.5 octane number or more. Fifteen cities reported decreases and 14 cities were unchanged. In regular gasoline, 29 cities reported increases over January in their average antiknock quality, two of them by 0.5 octane number or more. Twenty cities reported decreases while eight cities were unchanged.

Compared with the nationwide premium



For more data on advertised products, use Readers' Service Cards, last page.

**Girdler can help you find and apply licensed processes for improved chemical production**

To enable you to improve your competitive position in "tonnage" chemicals, Girdler offers this three-part engineer-constructor service:

**We know where to go** to secure licensed processes which may offer advantages to you in production economy or quality.

**We know how to translate** the process and plant design into U. S. standards and code requirements.

**We know how to apply** the process to your needs and to build and equip the plant.

May we discuss this with you in further detail?

**GIRDLER**

CONSTRUCTION DIVISION

NATIONAL CYLINDER GAS COMPANY

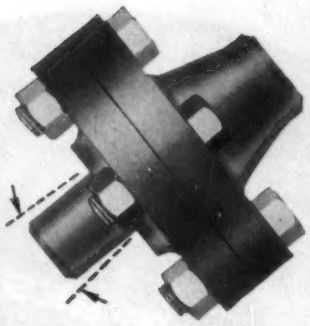
Louisville 1, Kentucky

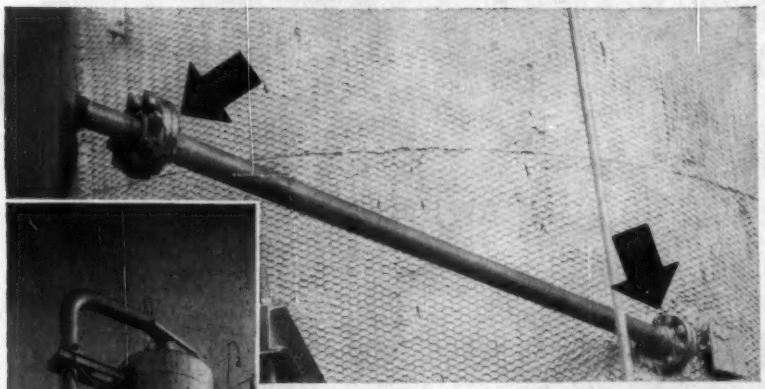
Sales Offices: New York, N. Y., San Francisco, Calif.
Engineering Offices: Louisville, Ky., Orlando, Florida

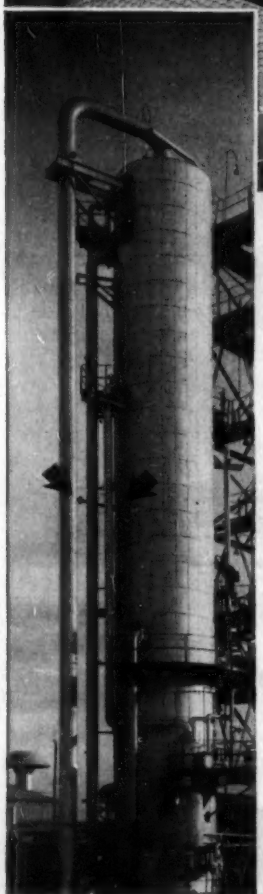


For more data on advertised products, use Readers' Service Cards, last page.

# HERE'S HOW
Engineers
and Builders Use
# BARCO FLEXIBLE STRUT JOINTS







## For Refinery Towers, Stacks, Large Piping

Barco Flexible Strut Joints are an important aid in modern refinery construction. A typical use is at the ends of struts for supporting or bracing large catalyst carrier lines or vent stacks on fluid catalytic crackers. In such cases, where lines require supports, two braces (with Barco Strut Joints in each) make costly "A" frames unnecessary. Also, they are frequently used in conjunction with hydraulic "snubbers" for vibration and pulsation control.

**SIMPLE, VERSATILE!**—The Barco Strut Joint is a dependable, compact, versatile fitting requiring practically no maintenance. It is a simple ball and socket that provides a point of flexibility in struts and guy rods. The close fit between ball and casing, allows for reversible loads, not possible with pin and clevis type braces. Barco Strut Joints support without restricting freedom of movement.

**COMPLETE LINE**—Available in following sizes and capacities: 1½"—14,500 lbs., 2"—20,000 lbs., 3"—40,000 lbs., 4"—80,000 lbs., 6"—120,000 lbs. Welding ends for field or shop use. No lubrication required.

**ENGINEERING SERVICE**—Barco will be glad to work with your engineers in the selection of joints to meet your requirements. *Specifications and information on request.*

**SEND for your copy of interesting new illustrated bulletin No. 28 showing uses of Barco Joints in the Petroleum Industry.**

**BARCO MANUFACTURING CO.**
542E Hough Street • Barrington, Illinois
*The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints*
In Canada: The Holden Co., Ltd., Montreal


## What's Happening. . .

average of 98.5 octane number, 12 cities reported premium averages of 99 octane number or higher. In regular gasoline, 18 cities showed average octane ratings of 91.5 octane number or higher, compared with the national weighted average of 91.1 octane number.

### Turbine Corrosion Reduced

A means of protecting high temperature gas turbine engines from corrosion was outlined to delegates at the Third Annual Gas Turbine Conference, sponsored by the American Society of Mechanical Engineers.

Gas turbine engines are most efficient at high temperatures and speeds. But, engineers have found that even if they make turbine parts out of the toughest metals and alloys the blades and other parts are corroded by the stream of hot combustion products, especially if low grade fuel is used. Three specialists from the Gulf Research and Development Co. proposed one solution to the problem in a technical paper describing recent laboratory tests.

Results of their studies showed that many substances such as micronized talc, magnesium oxide and potassium permanganate effectively reduced corrosion at costs ranging from less than one cent to about 11 cents per barrel of oil. Synthetic sea water and other materials containing sodium or potassium also reduced certain types of corrosion and enhanced the effectiveness of other corrosion-inhibiting additives.

### Health Conference Slated

New problems and progress in the control of occupational health hazards and the provision of preventive medical services by industry will be discussed at the Thirteenth National Industrial Health Conference, in Atlantic City, N. J., April 19-25. More than 3,000 occupational health specialists, businessmen and labor leaders will hear papers on problems of growing significance to industry, workers, and the community. A total of 134 papers will be presented on such subjects as radiation, mental health in industry, air pollution, noise, medical care and in-plant health services, industrial dentistry and industrial nursing.

### Auto Exhaust Control Costly

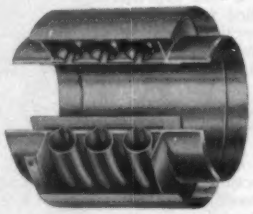
The independent Air Pollution Foundation, now directing its entire scientific research program to solution of the auto exhaust problem, has said the cost of control by currently proposed methods will probably be in the range of $50 to $85 per year per automobile.

The Foundation noted that this would result in an annual bill of $150 million to $250 million for the Los Angeles area with its 3 million autos.

Cost estimates for control methods most talked about were documented in a chapter, "Technical and Economic Aspects of Auto Exhaust Control Methods," in the Foundation's fourth annual Technical Progress Report.

Separate estimates were made for induction devices, direct-flame and catalytic

# NEW ZALLEA HyPTor* TOROIDAL EXPANSION JOINT



HyPTor corrugations have a circular or toroidal cross section which provides a lower operating stress at any given pressure than any other corrugation shape.

## For unequalled endurance at pressure and temperature extremes

**This unique toroidal expansion joint** with thin-walled bellows is setting new performance and durability records in high pressure, high temperature service. It was developed to meet the severest operating conditions without sacrificing long life.

**Minimum stress at high pressures** is one advantage of the Zallea HyPTor. This is due to the thin-walled bellows and toroidal corrugations. Thin walls develop lowest flexing stress. The toroidal cross section assures lower operating stress at any pressure.

**Superior performance at high temperatures.** The toroidal corrugation of the HyPTor makes it suitable for use at high temperatures. Also, the HyPTor is hydraulically formed and free from circumferential welds which would act as stress raisers.

**Longer life on the job.** The ability of the HyPTor to absorb punishment without ill effects has been proved in service. A number of HyPTor Expansion Joints designed for 700 psi working pressure, were installed in liquid oxygen service in 1948. They are still operating . . . at pressures up to 2300 psi.

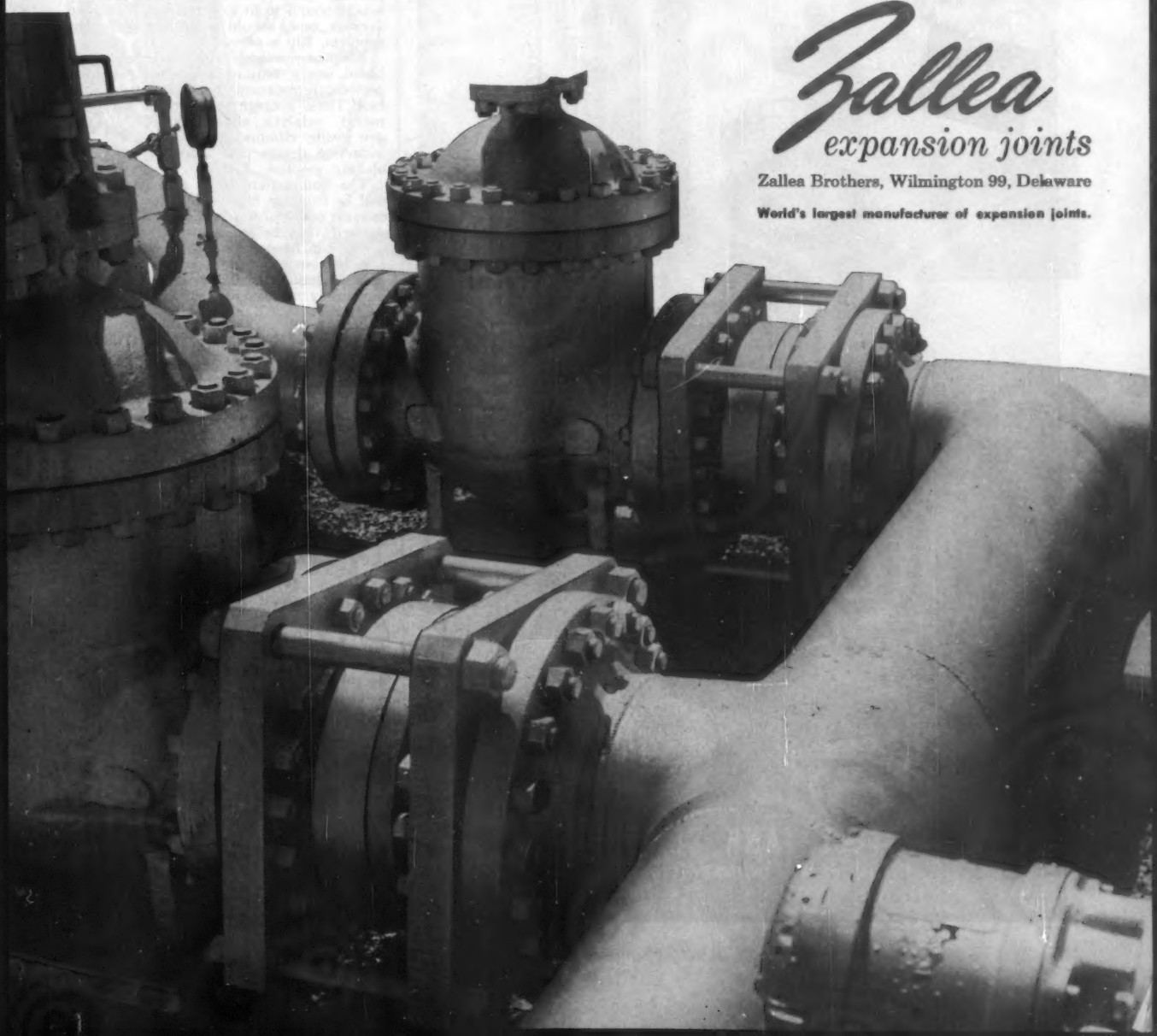
**Get the complete story** of the new Zallea HyPTor Expansion Joints. Our new 72-page Expansion Joint Manual gives full details—plus worthwhile information on basic types, design and installation data, expansion joint selection and recommended specifications. Write on your Company letterhead, for your free copy of Catalog 56, Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

*Patented

*Zallea*
*expansion joints*

Zallea Brothers, Wilmington 99, Delaware

**World's largest manufacturer of expansion joints.**



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Whether your fabricating requirements call for a tower, a complicated stainless steel vessel, or a giant storage tank, C.S.T. can handle it.
When you need fabricated vessels and process equipment, Chicago Steel Tank Company, with its facilities, know-how, and experience, can meet your most rigid requirements and code specifications. Call a C.S.T. sales engineer today.
Write for your personal copy of the C.S.T. facilities booklet.
Custom Fabricators and erectors since 1899
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## What's Happening. . .

afterburners, nitrogen oxide eliminators, fuel changes, and combinations of devices with modified fuels.

The inspection required to make a control program effective will depend on the nature of the control adopted, the Foundation pointed out, but will probably cost only about $1.25-$2.50 per year if required semi-annually, thus making cost of inspection "by far the cheapest part of the cost of control."

An induction device would probably cost the average car owner only $12 a year, the Foundation estimated. But since an induction device cuts hydrocarbon emissions only during deceleration, it would effectively reduce smog only if "deceleration hydrocarbons" are far greater smog formers than other hydrocarbons. While this possibility is not being overlooked in current research, it is believed most unlikely.

Another device costing less than $50 a year would be a direct-flame afterburner, the Foundation said, but so far no one has determined how to build one to burn exhaust gases successfully in a housing small enough to fit under a car. Estimated average cost, should some one solve the problem, $20 a year.

All other methods which have been proposed would require a catalyst requiring periodic replacement or a more expensive fuel. These average yearly costs were estimated: catalytic afterburner, $50; nitrogen oxide eliminators, $55; to $85; an induction device plus a higher cost nonolefinic gasoline, $50.

The Foundation thinks that it probably will be three to five years before the auto exhaust problem is solved. The agency has stressed that before a reasonably priced device can be developed, researchers must first find out which constituents of exhaust must be reduced and how much reduction is actually necessary to eliminate smog.

## O.U. Gets Aid for Engineers

Checks totaling $4,000 for support of Continental Oil Co. and Universal Oil Products Co. aid to chemical engineering students have been received by The University of Oklahoma.

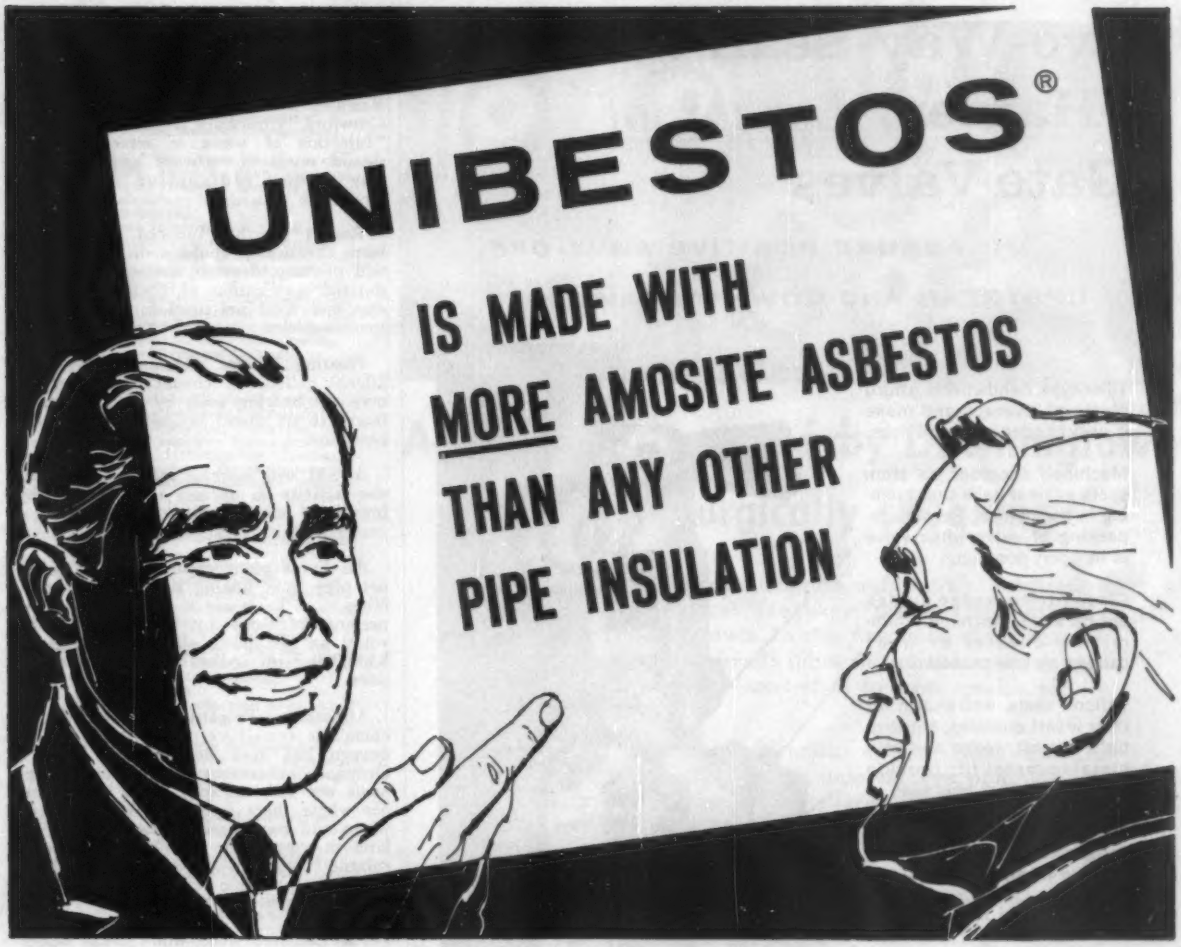
Continental, of Ponca City, annually grants a $1,500 fellowship to a graduate student in chemical engineering and $1,000 for use of the school. Universal, of Des Plaines, Ill., provides two $500 scholarships for upper classmen and contributes $500 as an addition to the budgeted funds of the OU chemical engineering school.

## Petroleum Congress Gets 250 Offers

Oil scientists and technologists throughout the world, including the United States, have been quick to respond to invitations to present papers at the Fifth World Petroleum Congress in New York in June, 1959. Their offers of papers detailing scientific and other advances in the international oil industry already exceed the 250 which it is expected will be given at the Congress.

Papers by U. S. authors are being selected by a committee which will also arrange for their subsequent presentation. This national committee, comprising prominent figures in the U. S. oil industry, is one of some 30 such groups around the world which are undertaking similiar responsibilities in their own countries.


For more data on advertised products, use Readers' Service Cards, last page.




## It's a *sure* way to save maintenance money!

Most insulations use merely a scattering of asbestos fibers to hold the mass together. So it's easy to see why UNIBESTOS is far stronger and so much *tougher*. Hammer blows can dent the surface, but never shatter nor crack it. You can cut UNIBESTOS cleanly without breakage—walk on it. And, best of all, UNIBESTOS can be removed and replaced repeatedly without damage or loss of efficiency.*

At competitive prices, rugged UNIBESTOS brings you the added advantages of easy installation, single-layer application, simplified fabrication for curves and fittings, unmatched resistance to water and weather. It's the favorite wherever used – the *standard* in plant after plant. We'll be glad to send you complete information on *re-usable* UNIBESTOS...the only pipe insulation made almost entirely of Amosite asbestos. Sizes to 44" o.d.

*At a southern refinery, UNIBESTOS on a 24" hot line in the cracking section has been removed for pipe inspection and cleaning every two months for more than four years. It has paid for itself many times over in maintenance savings alone.

UNARCO®

**UNION ASBESTOS & RUBBER COMPANY**
1111 W. Perry Street, Bloomington, Illinois

INSULATIONS • PACKING • GASKETING • ASBESTOS TEXTILES • INSULATING CEMENTS

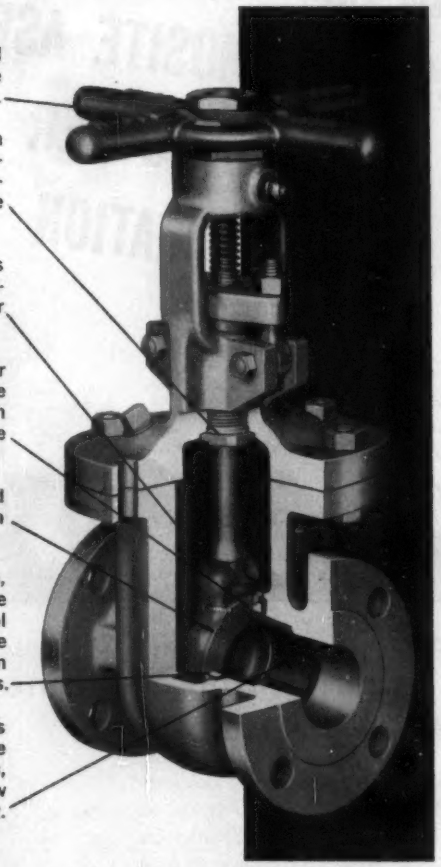


For more data on advertised products, use Readers' Service Cards, last page.

# Two-Way-Sealing Hamer *Leakproof* Gate Valves

**ASSURE POSITIVE SHUT-OFF**

**UPSTREAM AND DOWNSTREAM!**



Tiller-type handwheels afford plenty of leverage and make it easy to open or close valves.

Machined shoulder on stem seats against back seat bushing in the bonnet. Permits repacking of valve while valve is in open position.

Close-fitting wedge guides are carefully machined, minimizing chatter or wear caused by line pulsation.

Teflon* seals, well-known for their insert qualities, squeeze tight against wedge and with metal-to-metal fit, provide doubly effective line seal.

Hardened, precision ground wedge seating surfaces mean positive fit against seat.

Stainless steel locking rings, impervious to corrosive liquids, confine and control Teflon* seal rings to reduce expansion and contraction due to changing temperatures.

Welded stainless steel seats spell end to thread leakage common in many gate valves, permit installation of new seats with minimum effort.

You can count on absolute leakproof line shut-off when you install Hamer Leakproof Gate Valves... because Hamer Leakproof Gate Valves incorporate double sealing action—metal-to-metal fit of the wedge plus two Teflon seals. *Positive* shut-off, both upstream and downstream, saves the cost of double block and bleed installations required in many gate valve installations. Hamer Valves save money too because they last longer and require less maintenance.

If yours is a valve problem, regardless of type or application, it will pay you to call on Hamer for help.

***Send for FREE, illustrated catalog.***

**Hamer VALVES, INC.**

P. O. BOX 1851 • 2919 GARDENIA AVE., LONG BEACH 1, CALIFORNIA

*Reg. T. M. DuPont 58-2

*Representatives throughout the World*


## – Changing Times –

**Radioactive waste is being considered for use in secondary recovery methods.** Research is being done by Dr. George W. Crawford, University of Texas physicist. **"Injection of waste in some reservoirs should result in recovery and offer safe way to store radioactive waste,"** says Crawford.

**Rocket age has induced Hercules to form chemical propulsion division.** Group will produce, develop, design and sell industrial application of chemical propulsion and solid-fuel units for missiles and space vehicles.

**Floating tubular plastic bags,** holding 20,000 gallons of chemicals or fuel oil **may cut barging costs by 60-80 percent.** Bags can be towed in line like sea-going pipe line.

**ATSM will increase its already extensive activity** in organic solvents field by **forming a new committee,** D-26 on Halogenated Organic Solvents.

**Air Force plans expansion of its product pipe lines linking bases to refineries.** Nine more bases are to be connected. At present, 21 bases are linked. Air Force study at two bases **showed savings of $500,000 with installation of product lines.**

Atmosphere-Proof box for handling chemicals sensitive to moisture and/or oxygen has been developed by Navy's Ordnance Laboratory. **Reagents and equipment are inserted into unit's antechamber where there is only trace leakage of water and oxygen.** Dry argon gas circulates through inner chamber where nonvolatile chemicals used in researching modified inorganic chemicals are handled.

Plastic-coated wood won't decay under any moisture conditions, according to recently completed research reported by Society of the Plastics Industry. **Researchers say plastic sterilizes wood surface, keeps out decay fungi; kiln drying sterilizes wood interior.**

**Shell Development Co. has formed new laboratory** facility at Emeryville, Calif., **to undertake research into tomorrow's fuels and oils** for cars, aircraft and rockets. Lab represents $750,000 investment.

Increased plastics and chemicals production has caused Koppers Co., Inc., to form **plastics division and chemicals and dyestuffs division to replace former chemical division.**

**Esso Standard's Charleston, S. C. refinery** completed its **eighth straight year without a disabling or lost-time injury.** Plant has established company record for longest safe working period.

## ERRATUM

The thermo-syphon reboiler equation on page 138 of the Robert Kern article, "How to Design Tower Piping" (March 1958 PR pp. 136-142) is in error and should read as follows:

$$h = \frac{144 \times \Delta p \cdot f - \rho_{(h-s)} \cdot a}{\rho_h - \rho_{(h-s)}} \text{ ft.}$$

## MEETINGS CALENDAR

| | |
|---|---|
| **1958** | |
| **APRIL** | |
| 16–18 | Natural Gasoline Association of America, Annual Convention, Dallas. |
| 17–18 | Society of Petroleum Engineers of AIME, La.-Ark., East Texas and Miss. Petroleum Sections, Gas Technology Symposium, Site Unreported. |
| 20–23 | American Institute of Chemical Engineers, Montreal, Canada. |
| 22–24 | American Society of Lubrication Engineers, Annual Meeting, Cleveland. |
| 24–25 | ASME Management—SAM Conference, Statler Hotel, New York. |
| 27–29 | Independent Petroleum Association of America, Mid-year Meeting, Hotel Sherman, Chicago. |
| **MAY** | |
| 5– 7 | Purdue Industrial Waste Conference, Purdue University Memorial Union Building, Lafayette, Ind. |
| 5– 9 | API Safety and Fire Protection Committee, 11th Midyear Meeting, Cosmopolitan Hotel, Denver. |
| 8– 9 | Cost Reduction Conference, Sponsored by, and held at, Illinois Institute of Technology, Chicago. |
| 11–15 | ASME Oil & Gas Power Conference & Exhibit, Bellevue-Stratford Hotel, Philadelphia. |
| 12–14 | Analysis Instrumentation Division of the Instrument Society of America, Annual Symposium, Shamrock Hilton Hotel, Houston. |
| 12–15 | ASME, Oil & Gas Power Division Conference, The Bellevue-Stratford Hotel, Philadelphia. |
| 12–15 | API Division of Refining, Midyear Meeting, Statler Hotel, Los Angeles. |
| 19–21 | National Fire Protection Assn., 62nd Annual Meeting, Palmer House, Chicago. |
| 21–22 | Western Petroleum Refiners Assn., West Texas-New Mex., Regional Technical-Industrial Relations Meeting. Hotel Paso del Norte, El Paso, Texas. |
| 25–29 | API Pollution Control Association, Annual Meeting, Sheraton Hotel, Philadelphia. |
| 27–29 | Short Course in Gas Technology, Texas College of Arts and Industries. |
| 31–June 8 | Chemical Engineering Exposition and Congress, Frankfort, Germany. |
| **JUNE** | |
| 4– 6 | American Petroleum Institute, Oil Information Committee Meeting, Sheraton Hotel, Chicago. |
| 9–12 | ASME Materials Handling Conference, Public Auditorium, Cleveland. |
| 9–13 | Gordon Research Conference, Colby Junior College, New London, N.H. |
| 15–19 | ASME, Semi-annual meeting, Hotel Statler, Detroit. |
| 16–18 | American Association of Cost Engineers, 3rd. Annual meeting, Case Institute, Cleveland. |
| 16–21 | Short Course in Statistics Methods for Research Workers in Industry, North Carolina State College. |
| 18–28 | Chemical and Petroleum Engineering Exhibition, Olympia, England. |
| 22–27 | American Institute of Chemical Engineers, 50th Anniversary Meeting, Bellevue-Stratford Hotel, Philadelphia. |
| 22–28 | American Society For Testing Materials, Annual Meeting and Exhibit, Hotel Statler, Boston. |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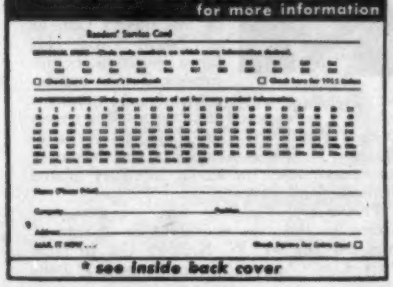
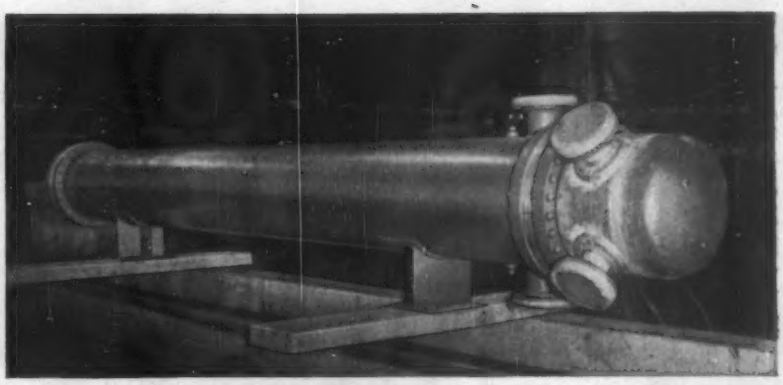


* see inside back cover





# Aluminum translated by Downingtown ...metallurgically speaking

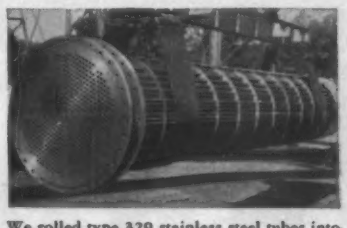
The special problems of aluminum welding and fabrication are another metallurgical "language" that has been expertly mastered at Downingtown. In this fixed-tube sheet heat exchanger unit, aluminum heads, tubes and tube sheets have been combined with a carbon steel shell to meet specific service conditions.

When heat transfer specifications call for aluminum...or aluminum bronze, nickel, copper, stainless steel, or almost any clad or alloy...you'll find the metallurgical idiosyncrasies are well understood at Downingtown. Send for our informative booklet on heat exchanger design.

**SPECIFICATIONS OF THE UNIT**

**Materials:** Aluminum Tube Side and Carbon Steel Shell
**Tubes:** 192 Alclad Tubes, ¾" O.D. x 16 ga. x 14'0" L
**Shell Diameter:** 18"
**Over-All Length:** 16' 1"
**Design Pressure:** Shell Side, 100 psi—Tube Side, 200 psi
**Test Pressure:** Shell Side, 150 psi—Tube Side, 300 psi
**Design Temperature:** Shell Side, 250° F.—Tube Side, 350° F.
**Code Stamped:** Inspected by Purchaser and Hartford

Putting the finishing touch on another heat exchanger unit built by Downingtown. We build to your specs, or do complete design.



We rolled type 329 stainless steel tubes into types 316 and 304 stainless tube sheets to make this stainless steel replacement bundle.

**Downingtown Iron Works, Inc.**
151 Wallace Ave., Downingtown, Pennsylvania
division of PRESSED STEEL TANK COMPANY Milwaukee
Branch offices in principal cities

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

# What's Happening . . .

## . . . *Among Men* in the Industry

**C. J. G. Leesemann** has been appointed head of the Supply and Coordination division in Humble Oil & Refining Co.'s Houston office. He has primary responsibility for coordination and liaison between the Refining department and other company departments, and between the Houston office, the Baytown Refinery, and customers. He also handles matters relating to coordination of production and supply of products.

Leesemann

Leesemann holds a B. S. degree in chemical engineering from Rice Institute.

**Frank L. Wallace,** who started his career with Texaco as a mechanical engineer in the Port Arthur refinery almost 39 years ago, retired February 1 as works manager of The Texas Co.'s Port Arthur works.

He was graduated from Purdue University in 1917 with a B. S. degree in mechanical engineering. Wallace started with the company as a mechanical engineer in the Fuels and Efficiency department of the refinery at Port Arthur. He served his entire tenure with Texaco at the Port Arthur plant, in engineering, supervisory and top management capacities.

In 1922 he was appointed foreman of the Power department. He was promoted to second assistant superintendent of the Port Arthur Works in 1930, then assistant general superintendent in 1934. He became general superintendent in 1939, and works manager in 1943.

**H. C. Pitcher** has been named construction manager for The M. W. Kellogg Co., New York. He will be in charge of all Canadian and South American construction for The Canadian Kellogg Co., Ltd., Toronto, and Kellogg Pan-American Corp., New York. He will head the construction activities of Kellogg's Fabricated Products division.

Pitcher

Pitcher joined Kellogg in 1935. He was a residential manager of construction at power plants, refineries and chemical plants from 1940 to 1947 and headed construction for the Fabricated Products division in 1948. He was made manager of U. S. construction in 1953. He left Kellogg from 1955 to 1957, and rejoined the company to take his present position.

Pitcher attended Washington & Lee University and the University of Buffalo.

**James D. Bushnell** has been appointed head of the fuels and treating section in the Standard Oil Co.'s (N. J.) planning engineering division. **Daniel Hartley** has been named head of the mechanical engineering development section of the design engineering division.

Since joining the company in 1947, Bushnell has worked on projects concerned with lube oil and wax processing. He has a B.S. degree in chemical engineering from New York University.

Hartley also joined Esso Engineering in 1947. His work has been in the design of refinery equipment. He has done research work on unit operations, and has served as chairman of the company's mechanical sub-committee on catalytic cracking. He has B.S. and M.S. degrees from Cornell University.

**Dr. Alex Lewis, Jr.** has been promoted to manager of Gulf Oil Corp.'s Petrochemicals department. Previously in charge of chemical marketing for the Petrochemicals department, he will succeed **L. O. Crockett** who was recently elected president of Goodrich-Gulf Chemicals, Inc., Cleveland. In his new capacity, Dr. Lewis will be concerned with direction of Gulf's petrochemical interests.

Lewis

Dr. Lewis began working for Gulf in 1935 at the Philadelphia refinery while a student at Ursinus College. Following his graduation in 1938, with a B. S. degree, he joined Gulf on a full time basis as an organic chemist in the Refinery Technology division. While working for Gulf, he received his M. S. degree from the University of Pennsylvania in 1940. He continued studies leading to his Ph. D. degree from the University of Pittsburgh in 1951. Gulf then appointed him a chief product engineer in the Product Development department. From 1953 to 1955, he was director of market development for Gulf's petrochemical activities.

**George W. Hedden, Jr.,** has been appointed assistant manager of manufacturing for the Organic Chemicals division, American Cyanamid Co., it was announced by **Dr. Wm. H. Bowman,** division general manager.

A native of New Jersey, Hedden attended Rutgers University, joining Cyanamid in 1932. Beginning as a trainee, he has served the company since then as a foreman, general foreman, superintendent, general superintendent, department manager, plant manager of services and assistant to the division manager of manufacturing.

**G. H. Hemmen** has been named manager, Commercial Development division, Research department, Union Oil Co. of Calif., according to an announcement by Fred L. Hartley, vice president for Research. In this capacity he assumes responsibility for the marketing of Union's technical developments.

Hemmen

Hemmen brings to his new assignment 20 years' experience in the manufacturing, research and engineering phases of the petroleum industry. His most recent assignment has been Chief Engineer of Union's Research department and previously he was manager of the Co.'s Oleum Refinery near San Francisco.

**Dan J. Forrestal** has been appointed director of public relations for Monsanto Chemical Co.

Forrestal succeeds **Howard A. Marple** who will take a leave of absence for reasons of health.

Forrestal, who has been manager of public relations for the company since 1954, came to Monsanto in 1947. He attended St. Louis University and was associated with the St. Louis GLOBE DEMOCRAT for 19 years where he served in the editorial department as feature editor, picture editor, war correspondent and assistant managing editor. In overseas assignments in 1945 and 1946, he represented North American Newspaper Alliance and Columbia Broadcasting System.

**Henry T. Fielding, Jr.,** is the new Eastern district manager for the Refinery Engineering Co. of Tulsa. He will have offices at 10 Rockefeller Plaza, New York City.

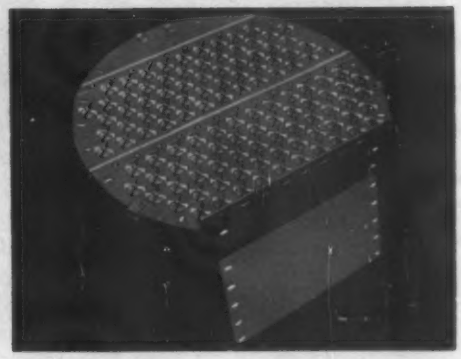
Fielding

Fielding has 17 years experience as an engineer, sales representative and sales executive. He holds a B. S. degree in aeronautical engineering from the University of Michigan's College of Engineering. His latest position before joining Treco was industrial sales manager of Borg-Warner Corp.'s Pesco Products division. At Borg-Warner, he was a member of the executive committee and industrial advisory board to the federal government.

Previously, Fielding was executive assistant to the vice president in charge of sales for the M. W. Kellogg Co. in New York City. At various times, he was con-

The need for higher capacities resulted in junking the above — after approximately two years of service! Installing *lower-priced Flexitrays in the first place* would have prevented this expensive — and unnecessary — replacement!

Where higher capacities are a necessity . . . ***Flexitrays are a necessity!*** Don't be caught with "yesterday's" equipment today — specify modern Koch Flexitrays!



Low-price Flexitray — for high capacity and extreme flexibility.

**Representatives:**

**Eastern Representative:** F. J. McConnell, 60 E. 42nd St., New York 17, New York
**Tulsa, Oklahoma Representative:** W. C. Myers Company, Wright Building
**Houston, Texas Representative:** Alpha Engineering Company, P. O. Box 12371
**Pittsburgh, Pennsylvania Representative:** D. D. Foster Company, 501 Alcoa Building
**West Coast Representative:** Jacobs Engineering Company, Pasadena: RYan 1-9373; Oakland, TEmplebar 2-5391
**Illinois Representative:** M. B. Fisher, 1521 Courtland Avenue, Park Ridge, Illinois
**St. Louis, Missouri Representative:** Sample Brothers, STerling 1-7941

**KOCH**

ENGINEERING COMPANY, INC.
321 West Douglas Avenue, Wichita 2, Kansas

*Continuing progress through research*



**For more data on advertised products, use Readers' Service Cards, last page.**

## Men in the Industry . . .

tract administrator of European jobs for Kellogg, assistant to the vice president in charge of sales at Canadian Kellogg and assistant to the manager of the glycerides processes division.

Before switching to the sales field, Fielding was assistant project engineer for the Fleetwings division of Kaiser Cargo, Inc., and weights engineer in Naval aircraft design for Brewster Aeronautical Corp., New York.

**Carl A. Ruscetta Jr.,** who received his B. S. degree in chemical engineering from the University of Massachusetts in 1957, has become a member of the industrial design department of Monsanto Chemical Co.'s Research and Engineering division at Dayton, Ohio, after serving with General Electric Co., Schenectady, N. Y.

Also, **James D. Phillips,** who received a B.S. degree in electrical engineering from Georgia Institute of Technology in 1957, has become a member of the engineering department of Monsanto Chemical Co.'s inorganic chemicals division, St. Louis.

**Reid A. Feather,** who received a B.S. degree in chemical engineering from the University of Kentucky in 1950 has become a member of the technical services department of Monsanto Chemical Co.'s organic chemicals division at Nitro, after serving as a process engineer with Ohio-Apex division of Food Machinery and Chemical Corp., Nitro.

**Wayne M. Talbert,** who received his B.S. degree in mechanical engineering from Texas A & M College in 1958, has become a member of the engineering department of Monsanto Chemical Co.'s Plastics division at Texas City.

**Ira S. Boydstun** has been appointed manager of a new Gulf Coast-Southwest area office in Houston for Chemical Construction Corp.

Boydstun

Engaged in Process design and sales for some 20 years, Boydstun has taken an active interest in the work carried on by the API committee on disposal of refinery wastes and is a member of the Air Pollution Control Assn., American Institute of Mechanical Engineers, and the Houston Engineering and Scientific Society. He was formerly sales manager for Petreco.

**W. J. Brown** and **H. H. Donaldson, Jr.,** have been appointed staff product application engineers in the Marketing Technical Service division of the Gulf Research & Development Co., research subsidiary of the Gulf Oil Corp.

Brown will be handling all steel plant technical service activities; Donaldson will be responsible for the coordination of technical service activities pertaining to trucks and buses and fleet operations.

A graduate of the Brown School of Petroleum, Marietta College, Marietta, Ohio in 1950, Brown was formerly the lubrication engineer of American Steel and Wire division, U.S. Steel Corp., Cleveland.

Following his graduation from Lehigh University in 1939 with a B.S. degree in chemical engineering, Donaldson joined the process section, Chemistry division of Gulf Research. Since 1954, he has been attached to Gulf's Toledo Sales division where he has represented the general office, Product Application in maintaining their technical activities with the automotive industry.

Both men will be headquartered at the research center at Harmarville, Pa.

**Oka Carlson** is manager of The Goodyear Tire & Rubber Co.'s new plastics plant at Apple Grove, W. Va.

Carlson

Carlson will have headquarters in Akron until the $9 million installation goes into production early in 1959.

Formerly superintendent of cascade operations at Goodyear Atomic Corp., Carlson has been with the Goodyear organization since 1941 when he joined the production training squadron in Akron. He was assigned the same year to fuel cell development at the Jackson, Mich., plant and late in 1948 was named division superintendent of tank tracks and extruded goods at Goodyear's Muncie, Ind., plant.

Made division superintendent of ex-


# Floridin

Adsorbents
Desiccants
Diluents

## around the WORLD

Floridin fuller's earth (aluminum magnesium silicate mineral) is recognized throughout the world for superior selective adsorption in laboratory and industrial separation processes.

From the basic Floridin, specialized processing increases the pore volume and available surface area. Commercial Floridin grades are unequalled in high quality and low cost:

- **Fuller's Earth Products:**
  Florex—for oil refining, Florigel—for collodial suspensions, Florco—for absorbent cleaners, and Diluex—for pesticide formulations.
- **Activated Bauxite Products:**
  Florite Desiccant—for gas and liquid dehydration and Florite—for petroleum refining.
- **Synthetic Adsorbent Products:**
  Florisil—for a highly selective chromatographic adsorbent.

**Our experienced adsorption specialists are available to help solve complex laboratory or production problems. Write for samples and technical information today. Dept. E**

FLORIDIN COMPANY
Adsorbents
Desiccants
Diluents

DEPT. E P. O. BOX 989 TALLAHASSEE, FLORIDA

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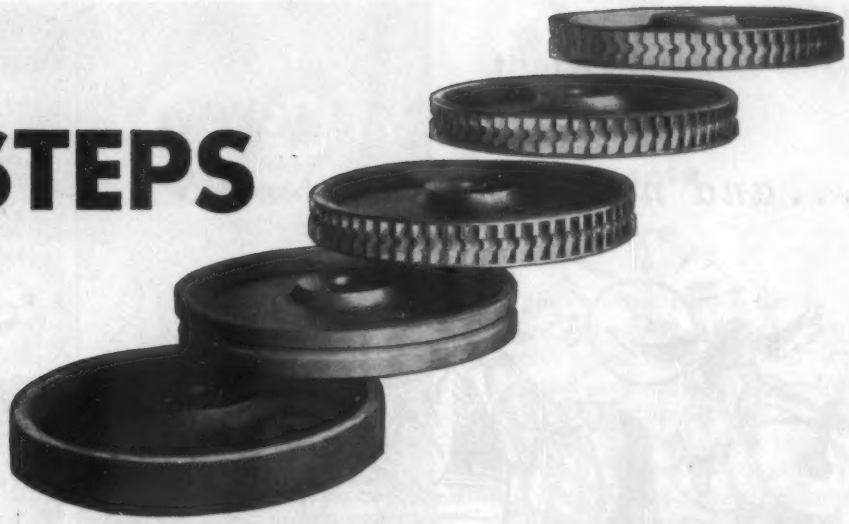
# 5 STEPS



## in making an almost indestructible turbine

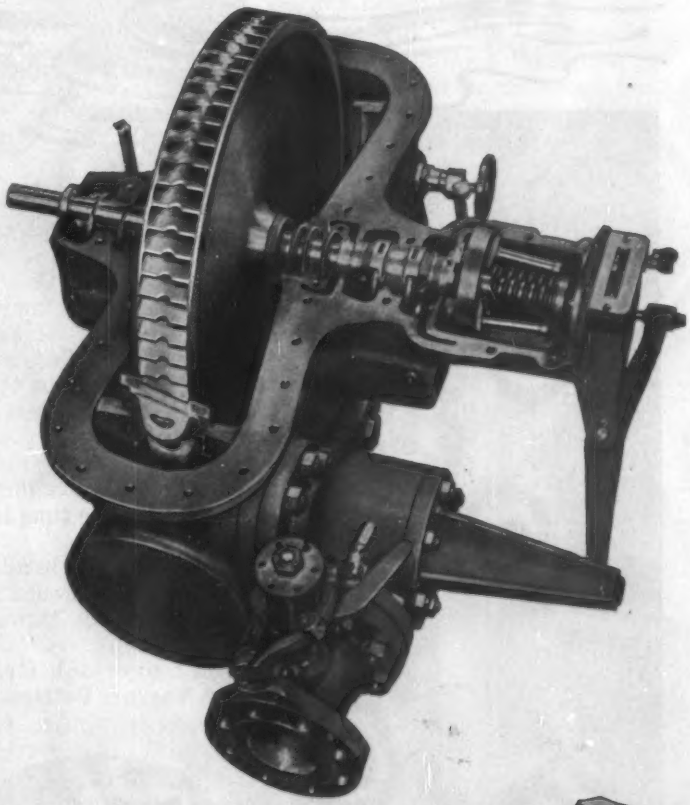
The rotor of a Terry solid-wheel turbine is a single forging of special composition steel. It is first rough turned in two operations, as shown, and then two cuts are taken to mill the semi-circular buckets from the solid metal. The wheel at the top has been finished, ready for mounting on the shaft. *The result is a single-piece wheel with no parts to loosen or wear out.*

Blade wear, which might occur after many years of usage, is not important, because the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets. Thus wear does not materially affect horsepower or efficiency.

The blades can't foul. They have a one-inch clearance, and are further protected by the projecting rims at the sides of the wheel.

The Terry solid-wheel turbine is an extremely reliable piece of equipment. Write for details—today. Ask for a copy of bulletin S-116.

**THE**
**TERRY STEAM TURBINE CO.**
TERRY SQUARE, HARTFORD 1, CONN.



**TERRY**

TT-1204



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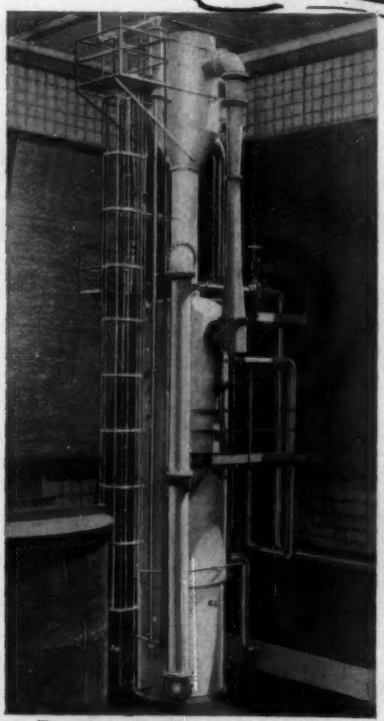
"Water,
water everywhere..."

*...and not a drop under 95°!*



Bowaters Southern Paper Corp. —largest, most modern newsprint mill in the South uses Graham Steam Vacuum Refrigeration.

Will this be *your* problem next July?

Perhaps old Sam Coleridge's famous quotation may well apply to your situation. Graham Steam Vacuum Refrigeration offers you the best solution to your process water requirements.

If you are going to be in need of colder water this summer, today is the time to plan for it.

Dependable, low in all costs, and tried and proved in hundreds of plants throughout the world.

Don't overlook Graham Steam Vacuum Refrigeration.

*Write for Bulletin 60-A*

Graham

**GRAHAM MANUFACTURING CO., INC.**

**415 LEXINGTON AVE., NEW YORK 17, N. Y.**

*Offices in principal cities and Canada*

***Heliflow Corporation***

## Men in the Industry . . .

truded goods at the new St. Mary's Ohio, plant in 1950, he assumed his most recent duties at Goodyear Atomic in 1952.

Born in Orebro, Sweden, Carlson was graduated from Northern State Teachers College in Aberdeen, S. D., in 1935 with a B.S. degree in education and earned a B.S. degree in chemical engineering from the University of Minnesota in 1941.

**E. R. Jones** has assumed supervision of all operations of the manufacturing facilities of the Derby Refining Co. refinery in Wichita, Kan.

Jones

Jones was employed by Derby in 1939 in the operating department at the refinery. Prior to joining Derby, he was employed by Skelly Oil Co., beginning as a laboratory technician and later advancing to process engineer. He is a graduate of Carnegie Tech, Pittsburgh, Pa., with a B.S. degree in chemical engineering.

Jones succeeded **Frank W. McCurry**, vice president in charge of manufacturing who recently retired. McCurry will continue to serve on the board of directors and act as a consultant on refinery problems. He joined Derby in 1923 as a chief chemist and has been vice president in charge of manufacturing since 1931.

**Paul B. Cravey** has just been named personnel manager for National Petro-Chemicals' Houston polyethylene plant which will be built this year.

Cravey received a B.S. degree at the University of Houston in 1950. Between 1941 and 1958 he was employed by Reed Roller Bit Co. in personnel and public relations work and was salary placement supervisor before joining National Petro.

**Glen S. Houghland** has retired following 29 years in development and process engineering with The M. W. Kellogg Co. Following graduation as chemical engineer from the University of Wisconsin in 1917, Houghland was employed successively by The W. E. Lummus Co., E. I. du Pont de Nemours & Co., Continental Oil Co., and The M. W. Kellogg Co.

**Alfonso de Leon,** who has a B.S. degree in chemical engineering from National University of Mexico, has been appointed to the newly created position of production manager of the Monsanto Mexicana, S.A. plant at Lecheria, Mex., after serving as plant superintendent there since 1956.

**Theodore S. Lawton,** formerly assistant director of sales for Monsanto's Plastics division, has been promoted to director of the newly consolidated market development department.

**Ralph F. Hansen,** formerly manager of market development for the Plastics division, has been promoted to assistant director of market development.

**Luigi A. Contini,** who received his B.S. degree in mechanical engineering from the U. S. Merchant Marine Academy and



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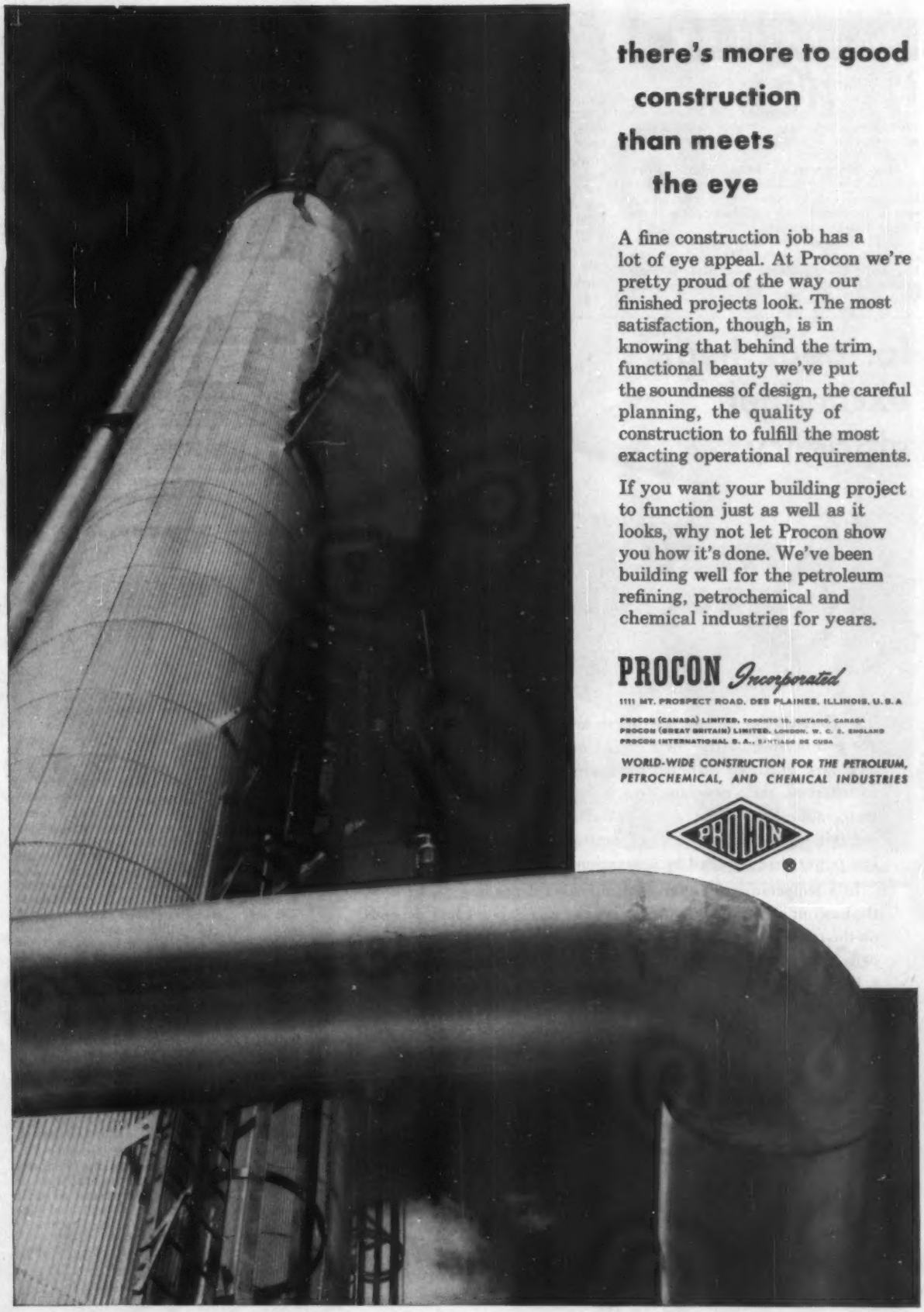

## there's more to good construction than meets the eye

A fine construction job has a lot of eye appeal. At Procon we're pretty proud of the way our finished projects look. The most satisfaction, though, is in knowing that behind the trim, functional beauty we've put the soundness of design, the careful planning, the quality of construction to fulfill the most exacting operational requirements.

If you want your building project to function just as well as it looks, why not let Procon show you how it's done. We've been building well for the petroleum refining, petrochemical and chemical industries for years.

**PROCON** *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA
PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND
PROCON INTERNATIONAL S. A., SANTIAGO DE CUBA

*WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES*

PROCON



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## Men in the Industry...

a M.S. degree in physics from St. Johns University, has been promoted to manager of creative design of the Plastics division's market development department, after serving as assistant manager of market development.

**Miss Margaret L. Reid**, who has an A.B. degree from Duke University, has been promoted to manager of market research for the Plastics division after serving as market analyst.

**S. F. Teague** has been appointed assistant director of industrial sales for the Inorganic Chemicals division after serving as district manager of the division's New York sales office.

**L. W. Sessions** has been appointed New York district manager for the Inorganic Chemicals division after serving as that division's district manager since 1956.

**W. P. Sheppard** has been appointed Detroit district manager for the Inorganic Chemicals division after serving as supervisor of distributor accounts at St. Louis since June, 1957.

**Matthew S. McCauley** has been appointed director of marketing research for the Organic Chemicals division after serving as director of business research since 1954.

**E. J. Bock** has been appointed assistant general manager of the Inorganic Chemicals division after serving as director of marketing since September, 1957.

**J. E. Crawford** has been appointed director of marketing for the Inorganic Chemicals division after serving as assistant director of industrial sales for that division since September, 1957.

**C. C. King** has been named manager of the Process Engineering department of The M. W. Kellogg Co., New York, a subsidiary of Pullman Inc. He has been associated with the company since 1939 and was made manager of the Chemical Process division in 1952.

King

King is known for his work in both the petrochemical and petroleum refining fields. Recently he was associated with the development of processes for ethylene, acetylene and butadiene, and has authored papers and patents on Algylation and Ethylene.

King holds a B.S. degree in chemical engineering and an M.S. degree in chemical engineering practice from Massachusetts Institute of Technology.

**Delbert P. Thompson** has been named The Refinery Engineering Co.'s 1957 "Outstanding Employee of the Year." Thompson, a construction superintendent, has been with the company since it was founded in 1942.

Thompson

Treco president **T. M. Lumly** presented Thompson with a wrist watch and plaque. He described Thompson as "a supervisor who has never been on a job that was not completely satisfactory in every way."

Thompson is the only employee, besides the president and founder himself, who has unbroken service with Treco since the day it started in business.

Thompson won the award for his work at Suntide Refining Co. of Corpus Christi, Tex., where he supervised construction of a Platformer, Unifiner and Udex unit, which went on stream in the fourth quarter of 1957.

The award winner holds patent rights on a number of inventions, many of which helped expedite jobs he has supervised.

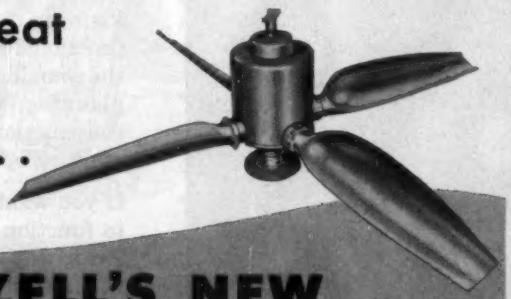
**Ralph W. Olmstead** has been named executive vice-president of The H. K. Ferguson Co., engineers and builders with headquarters in Cleveland.

The board of directors, in further action, appointed **James R. Fraser** vice-president, engineering, and **William E. Hark**, vice-president, construction.

Olmstead, transferred to the Ferguson Co. from Morrison-Knudsen Co., Inc., of Boise, Idaho, in 1954. He served as assistant to the president and was elected vice-president January, 1956. He became a director of the firm in 1956.

Fraser has been with the company for 16 years, and since March 1956, has been Ferguson's chief engineer. Prior to his appointment as chief engineer, he served as


for peak heat exchanger efficiency...



HARTZELL'S NEW CONTROLLABLE PITCH FAN

The Hartzell Controllable Pitch Fan meets a long-standing need in the petroleum industry for a precise method of controlling a variable flow of air to maintain predetermined temperatures. On test installations, these new fans have proved their ability to hold outlet temperature fluctuation to plus or minus 1½°F. And, while achieving this highly accurate level of control, they consume up to 50% less power than required by conventional fixed-pitch fans.

In a temperature sensitive control system depending on air flow, the amount of air required to achieve the necessary cooling depends on the temperature of the air. High air temperatures require high air deliveries, low air temperatures require minimum air deliveries. With a Hartzell Controllable Pitch Fan, variable air delivery is accomplished by variation in blade pitch setting. The fan assembly responds instantly and automatically to conventional temperature sensitive control equipment—increasing blade pitch to deliver more air when outlet temperature rises, decreasing blade pitch and delivering less air when outlet temperature falls.

For complete details on Hartzell's controllable pitch heat exchanger fan, write for Bulletin 111-B or call your nearby Hartzell field engineer.

HARTZELL PROPELLER FAN CO.
*Division of Castle Hills Corp.*
71 Thomas Blvd. Piqua, Ohio

## Why external recalibration is important to users of industrial thermometers

Sometimes it is necessary to recalibrate thermometers in industrial installations due to severe shock from rough handling, or to calibrate for extreme accuracy at any point on the scale for special work range.

To recalibrate the ordinary bimetal thermometer, you must remove the dial glass and move the pointer by hand. You will achieve the desired recalibration of course, but a number of undesirable things may also result. First of all, the instrument's air-tight seal is automatically destroyed in the removal of the dial glass. Secondly, in forcing the pointer, the pointer shaft may become bent or twisted.

Should the pointer shaft become bent even slightly, it can cause the pointer to stick due to improper alignment of the bimetallic shaft on its bearing surfaces. The obvious result, of course, will be inaccurate readings and necessary repair or replacement of the instrument. *None* of these things can happen with the RMC external recalibration device.

A simple dial-reset screw, located on the back side of RMC industrial thermometers, permits recalibration without opening the instrument in any way. This external recalibration feature is *exclusive* with RMC, along with true dry-air hermetic sealing.

SHIPPINGPORT, Pa.—Heavy-duty dial thermometers play an important role in the operation of the world's first full-scale atomic-electric generating station devoted exclusively to civilian needs. These thermometers, manufactured by RMC, can be recalibrated externally. The plant is a joint project of Westinghouse Electric Corporation, Atomic Energy Commission and Duquesne Light Company of Pittsburgh.

## RMC high pressure gauge, developed for missiles, now available to industry

RMC-LINDSAY PRESSURE GAUGES indicate pressures in ranges 0 to 1,000 psi., up to 0 to 15,000 psi., with retard scales available. Multiple coil, helical Bourdon tube type, with pointer attached direct—no linkages or pivots. Can withstand extreme shock, vibration, temperature, or overpressure and maintain consistent accuracy.

**Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill go to work for you. ROCHESTER MFG. CO., 38 Rockwood St., Rochester 10, N. Y.**

This maintenance engineer is recalibrating an RMC bimetal dial thermometer by means of the exclusive RMC *external* dial reset screw—a simple on-the-job operation with RMC thermometers.

# RMC external recalibration device saves thermometer's hermetic seal

With this *external* dial reset screw you can recalibrate your RMC thermometer easily and safely, should it ever be necessary. The all-important hermetic seal cannot be destroyed and there is no chance for damage to the critical pointer shaft. You get the *only* bimetal industrial thermometer that provides for *external* recalibration when you specify RMC.

RMC

**ROCHESTER MANUFACTURING CO., INC.**
**38 ROCKWOOD STREET • ROCHESTER 10, N.Y.**

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES

## Made to measure . . . *and made to measure up!*

# B&A® "Custom-Made" Chemicals

**Special chemicals** for virtually every need! Leading companies in many chemical processing fields regularly call on B&A's "custom-made" chemical service. One reason is the equipment you see here —typical of Baker & Adamson's modern, versatile facilities. These companies avoid many problems *and save money* by depending on B&A's *established* production facilities rather than manufacturing their own special chemicals.

**How you save:** When your new and special chemicals are custom-made for you by B&A, you save capital investment in plant and equipment . . . save on staff additions, too. You use your own production to best advantage—while B&A meets your special chemical requirements *exactly*, with dependable deliveries scheduled as desired.

**B&A** has the equipment, the experience, the skill you need! Baker & Adamson offers over 1,000 high purity chemicals . . . available in quantities ranging from small bottle lots of laboratory reagents to tank car and carload shipments of fine chemicals. This versatile manufacturing ability is at your service when you call on B&A for "custom-made" chemicals.

For a confidential discussion of your needs and how we can serve you, phone or write your nearest B&A office.

## BAKER & ADAMSON® Fine Chemicals

Allied Chemical

**GENERAL CHEMICAL DIVISION**

**40 Rector Street, New York 6, N.Y.**

*Offices:* Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cleveland (Miss.) • Cleveland (Ohio) • Denver Detroit • Houston • Jacksonville • Kalamazoo • Los Angeles • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • Portland (Ore.) • Providence San Francisco • St. Louis • Seattle • Kennewick, Vancouver and Yakima (Wash.) In Canada: The Nichols Chemical Co., Ltd. • Montreal • Toronto • Vancouver

## Men in the Industry . . .

district chief engineer of the company's Central district.

Hark joined the company 23 years ago as a field engineer and progressively advanced to the positions of construction superintendent, central district construction manager and since 1956 has served as the company's general construction manager.

**George F. Hornaday** has been made manager of the Research and Development division of Houdry Process Corp.

Hornaday

Hornaday, who had been associate manager of the division since December, 1956, heads operations at the Linwood, Pa., Research and Development Laboratories of Houdry. Before that, he was assistant process sales manager of the company.

Prior to joining Houdry in 1940 as assistant manager of development, Hornaday was with the then Socony Vacuum (now Socony Mobil) Oil Co. His experience includes catalytic cracker operation, reactor design, technical service, and participation in development of the Houdry Dehydrogenation Process, used for production of butadiene and butenes.

Hornaday received his B.S. degree in chemical engineering at Purdue University.

**Robert L. Merrick** has been made chief project engineer for Blaw-Knox Co.'s Chemical Plants division. He will be responsible for general direction of all project engineering, with specific emphasis on getting all design conditions firm and major equipment on order at the earliest possible date.

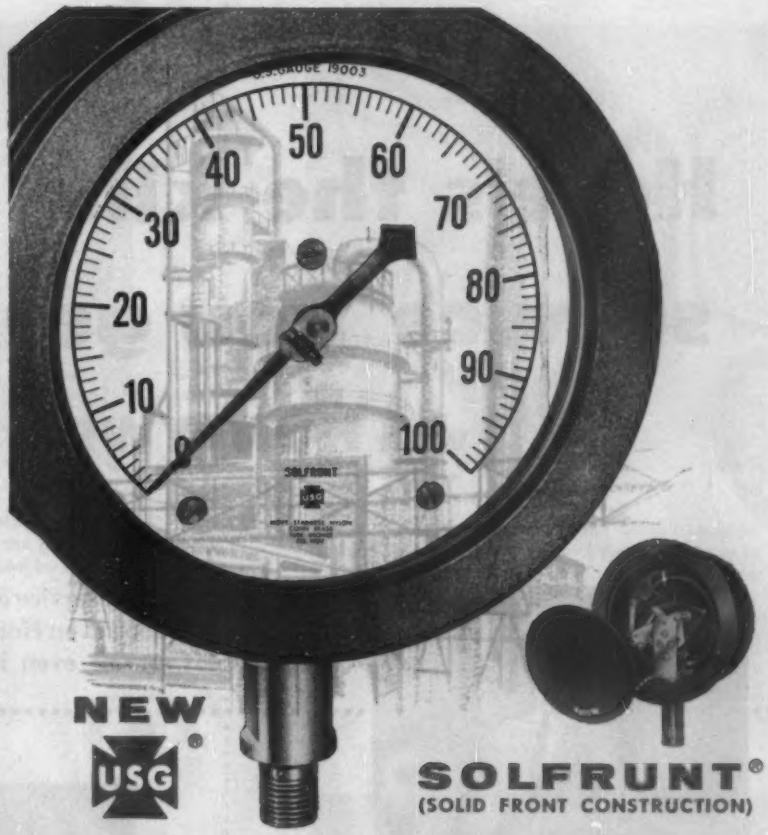
Merrick

Merrick has had over thirty years experience in the design and construction of process plants and complex structures. He recently served as president and general manager of Petrocon Engineering Co., where he supervised many expansion programs for the petroleum industry. Previously he was associated with the Fluor Corp., Ltd., as vice president in charge of its four Engineering divisions.

**H. Spicer Trail,** has transferred from Monsanto Chemical Co.'s Inorganic Chemicals division research department to the division's engineering department at St. Louis. He has served with the division's research department since 1957.

**H. K. Eckert** has been appointed assistant general manager of the company's Plastics division at Texas City, after serving as director of manufacturing since 1956.

**Dan J. Forrestal** has been appointed director of Monsanto's Public Relations


**designed for the refinery**
**SAFE...RUGGED...DEPENDABLE**

USG Solfrunt Gauges are ideal for refinery applications. They withstand combined high pressure and corrosive process conditions with the utmost safety and dependability.

**FEATURES OF THE USG SOLFRUNT GAUGE:**

- Behind the dial is a protective solid metal wall. A weather-tight rubber disc in the rear releases pressure in event of a tube rupture. Extra long life, dependable, accurate service is assured from the gauge movement which has a section of stainless steel with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions. (An all-stainless movement can be supplied if conditions so dictate.)
- Arc-Loc® Movement and gauge construction permit complete recalibration by merely removing the blowout disc.

Solfrunt Gauges are available in 4½", 6" and 8½" sizes, for pressures to 20,000 psi. Call your local USG Distributor today . . . his name is in the "Yellow Pages" of your phone book . . . or write for complete information on gauge styles and construction.

UNITED STATES GAUGE
USG
*Home of the* SUPERGAUGE®
Division of American Machine and Metals, Inc.
Sellersville, Pa.

MORE THAN 50,000 TYPES OF GAUGES • SUPERGAUGES • SOLID FRONT GAUGES • RECEIVER GAUGES • TEST GAUGES • RECORDERS • CONTROLLERS • TRANSMITTERS • PSYCHROMETERS • AVIATION INSTRUMENTS

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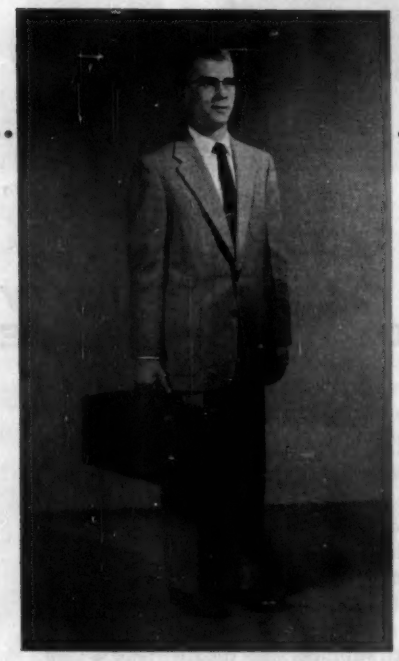
# Here's the kind of service you get . . .

## with HONEYWELL instrumentation

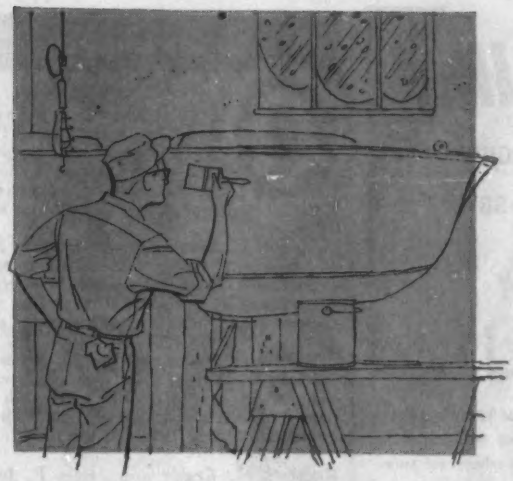


Bill Lewis, typical service engineer, proves how you can depend on Honeywell for fast, on-the-spot service even in emergencies.

**3** It took Bill two hours to drive to the plant through the storm. He spotted the trouble immediately; a thermocouple and its protecting tube had burned out. It might have meant four to five thousand dollars' worth of damage.

Honeywell service begins when you first decide you need instruments; and continues long after they're installed. It includes:

- Preliminary engineering, even before specifications are written.
- Application engineering for installation and startup.
- Service engineering help from your nearby Honeywell branch.
- Periodic service and swift help in emergencies.
- Training of your operators at the Honeywell Instrumentation Education Center.



**1** Bill Lewis, service engineer at Honeywell's Fort Wayne branch, was in his garage, touching up the paint on his 13-foot outboard. The bowling match had been called off that night because of the snowstorm, and Bill was glad to be home.

**2** At 9:30 a call came from the Crosby Laughlin Division of American Hoist and Derrick Company in Fort Wayne. A controller on a galvanizing kettle wasn't working and unless it was fixed fast, the pot would either freeze or burn out. Bill said he would be out right away.

**4** Bill didn't have a thermocouple with him that would fit, so he improvised a temporary couple and protecting tube and got the system going. Early the next morning he called the Honeywell branch in Indianapolis and had the correct thermocouple and tube shipped quickly to the plant. Next day, he carefully checked out the entire installation.

**5** Now, Crosby Laughlin Division is signed up with the Honeywell Periodic Service Plan, and its complete instrumentation is checked and serviced every month. Any spare parts needed are now available at Honeywell's Fort Wayne branch. Bill hasn't had to make another emergency call to the plant since.

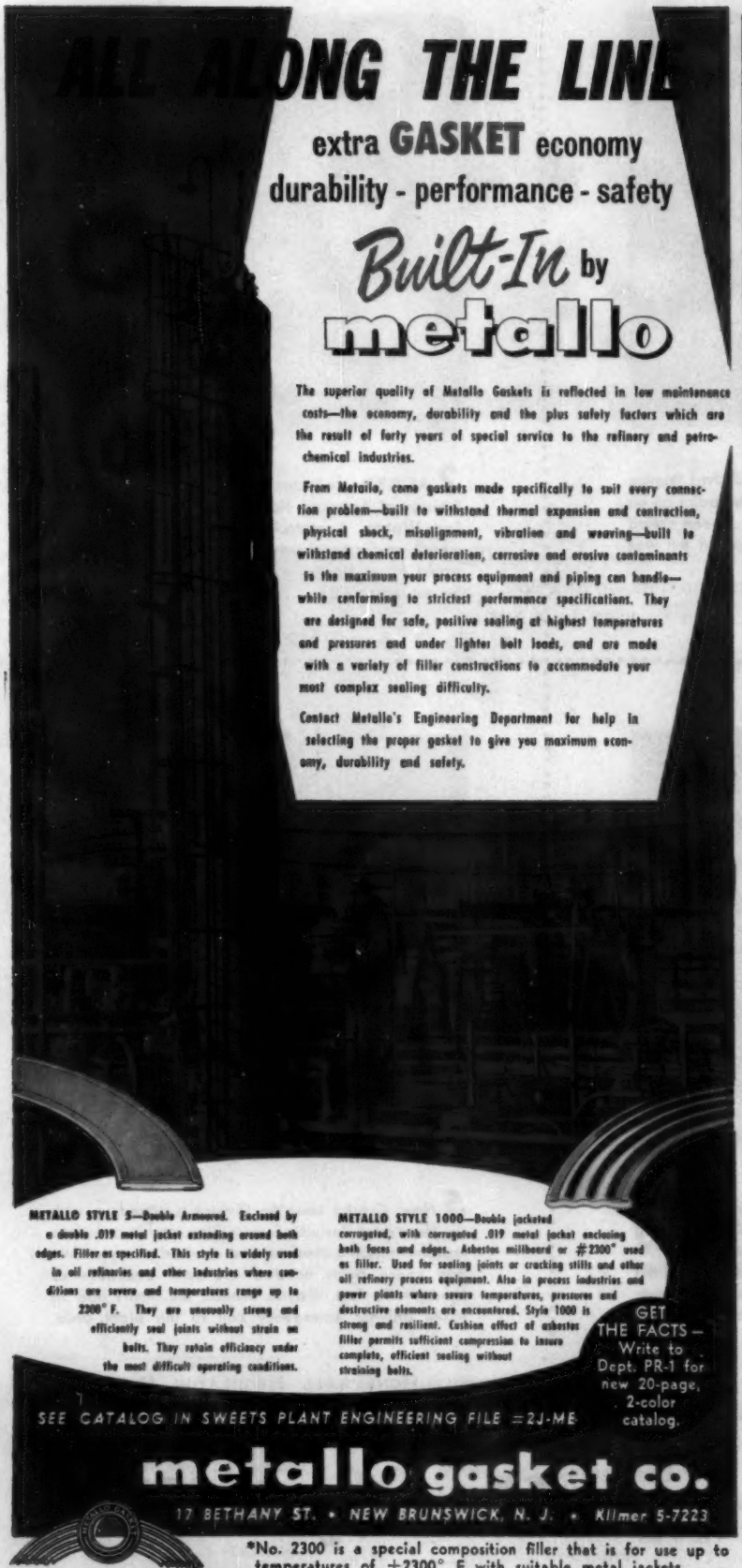
Around-the-clock help in emergencies is but one of many Honeywell services that give you extra value for your investment in instruments. Get the complete service story from your near-by Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Products Group* . . . Brown Instruments, Wayne and Windrim Avenues, Philadelphia 44, Pa.

# Honeywell

H HONEYWELL

*First in Controls*


ALL ALONG THE LINE
extra GASKET economy
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The superior quality of Metallo Gaskets is reflected in low maintenance costs—the economy, durability and the plus safety factors which are the result of forty years of special service to the refinery and petrochemical industries.
From Metallo, come gaskets made specifically to suit every connection problem—built to withstand thermal expansion and contraction, physical shock, misalignment, vibration and wearing—built to withstand chemical deterioration, corrosive and erosive contaminants to the maximum your process equipment and piping can handle—while conforming to strictest performance specifications. They are designed for safe, positive sealing at highest temperatures and pressures and under lighter bolt loads, and are made with a variety of filler constructions to accommodate your most complex sealing difficulty.
Contact Metallo's Engineering Department for help in selecting the proper gasket to give you maximum economy, durability and safety.
METALLO STYLE 5—Double Armored. Enclosed by a double .019 metal jacket extending around both edges. Filler as specified. This style is widely used in oil refineries and other industries where conditions are severe and temperatures range up to 2300° F. They are unusually strong and efficiently seal joints without strain on bolts. They retain efficiency under the most difficult operating conditions.
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*No. 2300 is a special composition filler that is for use up to temperatures of +2300° F with suitable metal jackets.


## Men in the Industry . . .

department, St. Louis, after serving as manager of that department since 1954.

**James E. McKee** has been appointed assistant director of the Public Relations department, St. Louis, after serving as assistant manager of that department since 1954.

**Joseph L. Montague** will transfer from the Inorganic Chemicals division research department to the division's engineering department at St. Louis after serving with the division's research department since 1957.

**Robert D. Nation** will transfer from the Inorganic Chemicals division engineering department to the division's research department, St. Louis, after serving with the engineering department since 1955.

**Robert H. Craft** and **James F. Jungé** have been elected new directors of Commonwealth Oil and Refining Co., Inc., Ponce, Puerto Rico.

Craft is the president of Chase International Investment Corp., foreign financing subsidiary of The Chase Manhattan Bank.

Jungé is an independent petroleum engineer with Wellington & Woodward, industrial consultants.

**J. L. Patton** has been named manager of the Chemical Process division of The M. W. Kellogg Co., New York. He has been with the company since 1944 and was a section manager in the Petroleum Processes division prior to his new appointment. He was formerly with the Magnolia Petroleum Co. and the Tennessee Valley Authority.

Patton holds a professional engineers license in Texas and New York, and a B.S. degree in chemical engineering from the University of Tennessee.

**Roland A. Whealy** has been named refining technologist in the Office of Oil and Gas, Department of the Interior.

Whealy will be responsible for programs involving refining, synthetic fuels, and natural gasoline.

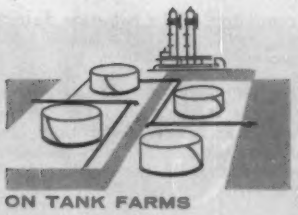
Prior to entering government service Whealy worked for the Ashland Oil and Refining Co., Ashland, Ky. During the past three years he has been coordinator of refining and sales. From December 1950 to November 1954, as superintendent of refineries, he handled maintenance and operation of eight refineries in four states. Before that, he served as refinery superintendent and operating superintendent of certain refineries. Experience previously included that of chemical engineer, process supervisor, salesman, road oil foreman, and oil analyst. He also spent two years as a research assistant at the State University of Iowa.

He has a B.S. degree from Eastern State Teachers College, and a M.S. degree from the State University of Iowa.

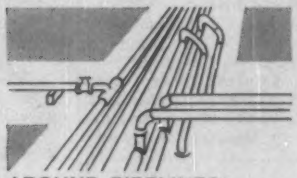
**E. Kenneth Burger,** a chemical market research expert with the Esso Standard Oil Co., has announced his retirement from the company. Burger has been manager of the Market Analysis division of the Chemical Products department for twelve years. He will be retained as a consultant.

Burger is a past president of the Chemical Market Research Association.

During World War II he was chief of



ON TANK FARMS



AROUND PIPELINES



AT WELL SITES

# stop weeds and fires before they start

get preventive weed control with

# GEIGY SIMAZINE* 50W

pre-emergence residual herbicide with

# 7 SAFETY FEATURES

Weed control is an old problem to the petroleum industry. Now Geigy's pre-emergence herbicide Simazine 50W provides a new and better solution – makes weed control *easier* because it is long residual; *safer* because of its Seven Safety Features; and *more effective* because it stops weeds before they start.

**ONE APPLICATION PER SEASON**

Simazine 50W reduces application costs in time, labor and material. At the rate of 10 lbs. per acre, one pre-emergence application controls annual grassy and broadleaf weeds for an entire season. At the rate of 20 lbs. per acre, one pre-emergence application controls most perennial weeds as well as annuals.

**SEVEN SAFETY FEATURES**

Oil maintenance men especially appreciate Simazine 50W's Seven Safety Features. This new herbicide is safe to humans and animals, non-flammable, non-corrosive, non-abrasive, and presents no conductivity problem or drift hazard. Check the panel for these and all of Simazine 50W's Seven Safety Features – and compare.

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   Minimum lateral leaching. Remains where it is applied.
3. **SAFETY TO SPRAYING EQUIPMENT**
   Non-corrosive or abrasive to equipment.
4. **SAFETY NEAR ELECTRICITY**
   Relatively low electrical conductivity.
5. **SAFETY FROM DRIFT HAZARD**
   Works through roots—little or no toxicity to foliage.
6. **SAFETY FROM FIRE HAZARD**
   Non-flammable. No application hazard.
7. **SAFETY ON VALUABLE LAND**
   Not a permanent soil sterilant.

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## Men in the Industry . . .

the program section in the Chemicals division of the War Production Board. During the Korean conflict, he served as a part-time consultant to the National Production Authority.

**Burton W. Pickard,** president of The California Oil Co., Perth Amboy, N. J., has been elected New York-New Jersey district chairman of the Oil Information Committee of the American Petroleum Institute for 1958.

In this new post, Pickard will head the steering committee of the two-state district and direct the oil industry's public relations program.

A native of Minnesota, Pickard started with Standard Oil of California as a branch manager on the West Coast in 1922. After a series of management positions, he served as assistant general sales manager before being named to the presidency of Calso in 1955.

**H. R. Moorhouse,** secretary and treasurer of Arthur G. McKee & Co., has been elected executive vice-president. He will also continue as treasurer.

**C. H. Ganzenmueller,** assistant secretary and assistant treasurer, has been elected secretary of the company and will continue as assistant treasurer.

**Clark P. Lattin, Jr.,** has been elected vice president and general manager of the Process Plants division, Foster Wheeler Corp. Lattin was formerly manager of sales for the Process Plants division.

Lattin

A graduate of the University of Delaware, Lattin has worked for Foster Wheeler Corp. since 1938, first as a design engineer, later as manager of Boston Sales Office and later as assistant to the vice president in charge of sales.

**B. R. Putnam, Jr.,** has been named manager of the petrochemicals department of American Cyanamid Co.'s organic chemicals division.

A graduate of Princeton University, Putnam has been with Cyanamid since 1947 when he joined the company as a chemical engineer. He joined Cyanamid's market research department in 1949 and was named manager in 1952. Since 1955 he has been manager of market development for the company.

**E. J. Karle** is the new manager of operations at the Perth Amboy refinery of The California Oil Co.

Karle will replace **R. H. Rowland,** refinery manager for the past five years, who has been transferred to San Francisco.

Karle, a University of Michigan graduate, has a background of 20 years refining experience with the company.

Other changes announced by Caloil include appointment of **W. R. Forsythe** as general superintendent; **A. H. Waldchen,** superintendent, catalytic operations; **C. V. Shireman,** superintendent, manufacturing and utilities; **W. R. Gentry,** superintendent, oil movement and security; **D. B. Edmondo,** superintendent, planning.

**James S. Clarke** and **Harry F. Moore** have been appointed senior engineering associates by the executive committee of Esso Research and Engineering Co.

Clarke joined the company in 1937. His company work has been connected with process and mechanical engineering and design and development work. He has B. S. and M. S. degrees in mechanical engineering from Rutgers University.

Moore joined the company in Aruba nearly 30 years ago. After six years there, he returned to the U. S. and has since been in Esso Engineering. His work has chiefly concerned automatic controls and instrument development. He earned a B. S. degree in electrical engineering at the University of Illinois.

**John Lee Olsen** was named assistant director and **J. Harold Perrine** administrative manager of Sun Oil Co.'s Research, Patent and Engineering departments. Olsen was formerly an assistant director of the Research and Development department and Perrine was manager of R and D's Administrative division. In addition, **Richard Fleming,** formerly a section chief in the department's Process Development division of the Marcus Hook, Pa., refinery was transferred to Olsen's new group.

As assistant director, Olsen will continue his responsibilities for the Technical Economics group. In addition, he will assist in coordination of the programs of the Re-


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**Tube Expanders for Condensers**

No. 255—for average tube sheets

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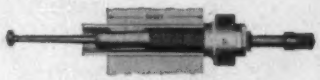

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IDEAL Ball Bearing Tube Expanders are made of special analysis alloy tool steels, carefully heat-treated to withstand the severest operating strains. They are adaptable for use with any torque controlled tube rolling units—air, electric or mechanical. *Confidence* is your assurance that your job will be done *RIGHT* . . . when you use WIEDEKE Specialized Tube Expanders, Tube Cutters and Operating Accessories. There is a Wiedeke Distributor in every principal city. For further information write for *new* General Catalog 81.

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**Dayton 1, Ohio**

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Operating results of HUDSON Solo-aire units installed in oil, gas and chemical plants throughout the free world have led to continuing repeat installations.

For new process installations and for replacement of high maintenance water-cooled equipment, Solo-aires offer in most cases clear-cut advantages. Let HUDSON assist you in objective analyses of air versus water cooling.

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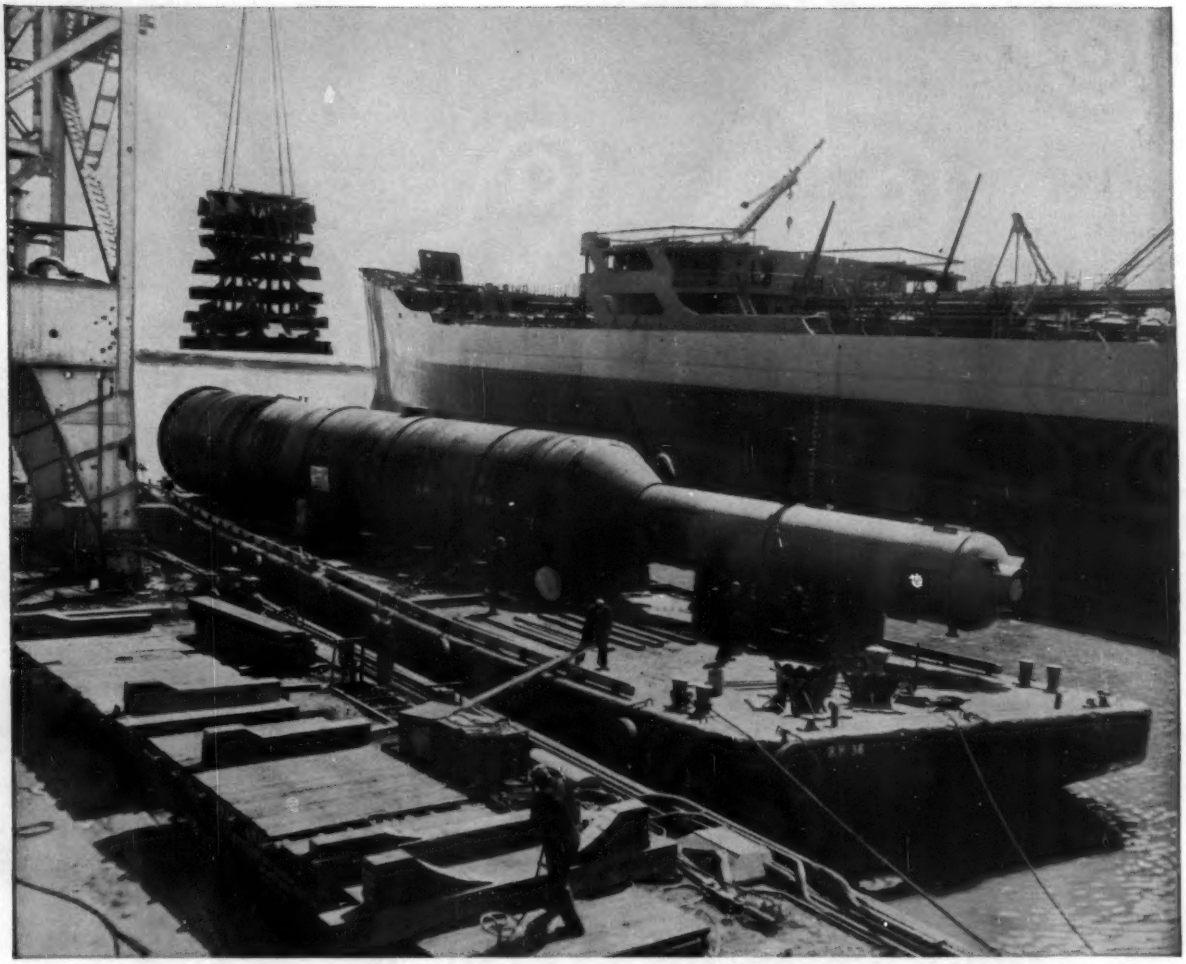

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search and Development, Patent and Engineering departments.

Perrine now is responsible for personnel administration, budgets, communications, collective bargaining and staff assistance.

Olsen joined Sun after graduation from Cornell University in 1944 with a degree in chemical engineering. After posts in R and D at Marcus Hook, he was placed in charge of the Technical Economics group in Philadelphia in May, 1953. He was named an assistant director of R and D on June 1, 1956.

A research engineer for 14 years with Sun, Perrine became an administrative assistant in the Manufacturing department in 1944. He moved to R and D in 1948 and was named manager of the Administrative division in May, 1953. He has a degree in chemical engineering from Grove City College.

Fleming started with Sun in 1954 as a section chief in the Process Development division of R and D. He received his B.S. degree in chemical engineering from Columbia University in 1944 and his M.S. degree in 1949 from New York University.

**Russell G. Dressler** has joined C. W. Nofsinger Co. as a consultant. He will also be the Gulf Coast technical and sales representative for Nofsinger.

**Chien Liu,** Edgar G. Carson, and **Frank J. Henglein** have joined the engineering and design staff of Scientific Design Co., Inc.

Chien Liu, who moves to Scientific Design's Engineering Development division from Hydrocarbon Research, Trenton, N. J., obtained a B.S. degree from Tsing-hua University, China, in 1946. He received M.S. and Ph.D. degrees from the University of California.

Carson, who has joined SD's Piping division, was previously with F. H. McGraw & Co., New York. He completed studies for the B.S. degree and also did graduate work at the Newark College of Engineering.

Henglein, previously a piping layout designer with Foster Wheeler Corp., has also joined the Piping division. He studied mechanical engineering through International Correspondence Schools.

**L. M. Snyder,** vice chairman of the board of Aramco Overseas Co., has been elected chairman and chief executive officer of the company. Snyder is also a vice president of the Arabian American Oil Co. He will continue to make his headquarters in Dhahran, Saudi Arabia.

**John H. Smith** has been named to the newly created post of chief design coordinator in Sun Oil Co.'s Manufacturing Engineering division. Formerly project engineer, Smith assumes general supervision of the division's design section.

Also announced, were the appointments of **Fulton K. Niece** as project engineer succeeding Smith, and of **H. George Shimp** as process engineer. Niece was previously assistant project engineer and Shimp was assistant process engineer.

A Sun engineer since 1929, Smith holds a certificate in mechanical engineering from Drexel Institute where he also took advanced design work. He also holds a civil engineering certificate from the International Correspondence Schools.

Niece joined Sun in 1948 as a draftsman. A graduate of Webb Institute of Naval Architecture with a B.S. degree in naval architecture and marine engineering, he has completed Pennsylvania State University's three-year extension course in petroleum refining.

Shimp started with Sun's Engineering division in 1948 after previous experience with Houdry Process Corp. He is a graduate of Purdue University with a B.S. degree in chemical engineering.

**W. C. Johnson** has joined Engineering division, **G. V. Chambers, J. E. Helbig, G. M. Marcus, N. P. Neureiter,** and **D. J. Wynnemer** are new members of Research and Development division, and **R. A. Blomé, R. W. Cox, F. W. Hansen** and **G. P. Reynolds** are now with Technical Service division at Humble Oil & Refining Co.'s Baytown, Texas, refinery. **C. N. Coleman** and **R. C. Russell** have returned to Technical Service division from military service.

Johnson holds a B.S. degree in mechanical engineering from Texas University; Chambers, B.S. degree in wildlife management and M.S. degree in chemistry, Texas A & M; Helbig, B.S. degree, chemical engineering, Rensselaer; Marcus, B.S. degree, chemical engineering, Northeastern, M.S. degree, University of Michigan; Neureiter, A.B. degree, chemistry, University of Rochester, Ph.D. degree, Northwestern; Wynnemer, B.S. and Ph.D.

## Men in the Industry . . .

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**(Zinc Chromate Organics)**

- ✓ Proved in Cooling Systems for over 11 years
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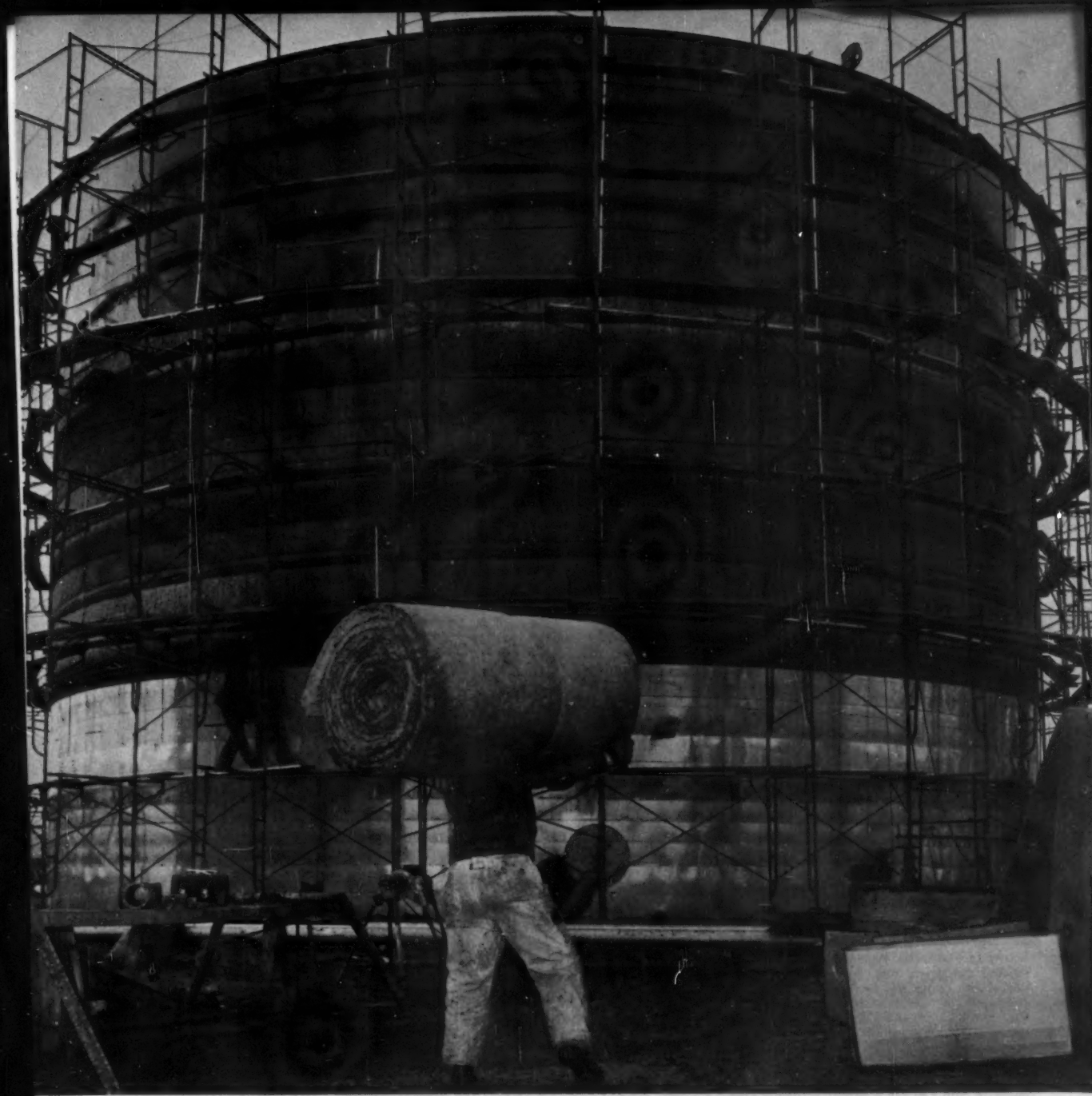

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WICHITA, General Metals, Inc.
VANCOUVER, B. C., Fleck Brothers Limited

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## Men in the Industry . . .

degrees, chemistry, University of Minnesota; Blomé, B.S. degree, chemical engineering, Tulane; Cox, B.S. and M.S. degrees, chemical engineering, Ohio State; Hansen, B.S. degree chemical engineering, Vanderbilt; Reynolds, B.S. and M.S. degrees, and Russell, B.S. degree, chemical engineering, Georgia Tech; and Coleman, B.S. degree, chemical engineering, Rice.

**Robert J. Askevold** and Dr. **Donald C. Bond** have been named to newly created positions as assistant research directors of the Pure Oil Co., and Dr. **Milton M. Marisic** has been appointed assistant manager of the company's Research Center at Crystal Lake, Ill. Askevold will be in charge of marketing and refining research activities, and Dr. Bond in charge of production and transportation research.

**M. J. Carnesale** has been appointed assistant vice president of sales for portions of the United States and all of Central and South America for M. W. Kellogg Co.

At the same time **W. T. McCay** was appointed assistant vice president of sales for the Mid-Continent and Gulf Coast area; **J. A. Petrie**, assistant vice president of sales for the Eastern Hemisphere and Canada; and **J. M. McAneny**, assistant vice president of sales of fabricated products and of engineering and construction services other than those associated with the Petroleum and Petrochemical industries.

Also, **L. J. Kelly** was appointed assistant vice president—engineering; **H. R. Schuster**, assistant vice president—procurement; **J. W. Smith**, assistant vice president—construction; and **F. E. Johnson, Jr.**, assistant vice president—contract operations.

**James C. Hance** has been named manager, Market Research, of Jefferson Chemical Co.'s Commercial Development division. Hance will be responsible for all phases of market research. He is transferring to Jefferson from American Cyanamid Co. where he has been for the past four years. His most recent assignment there has been in the Market Research department. He received his B.S. degree in chemical engineering from Purdue University in 1951 and his M.A. degree in business administration from New York University in 1957.

**Dr. Walter C. Bradbury** recently joined the staff of the Cities Service Research and Development Co., Product Development Laboratory at Cranbury, N. J., as a section head in the Analytical division.

Bradbury holds a B. S. degree from Mercer University, M. S. degree from the University of Georgia, and a Ph. D. from the University of Arkansas. He had previously been associated with the Celanese Corporation, Dow Chemical Company and the Upjohn Co.

**E. Leonard Borg** has been named manager of synthetic rubber development for the Naugatuck Chemical division, United States Rubber Co.

Borg joined Naugatuck Chemical at Naugatuck, Conn., in 1942 as a technical trainee in the synthetic rubber division. He holds a B. S. degree in chemical engineering from Rensselaer Polytechnic Institute,


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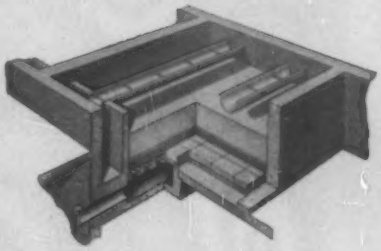
FILTER BOTTOMS

Successfully meet all underdrain requirements



Filter unit showing Leopold Filter Bottom and Leopold Fiberglass-Reinforced, Plastic Wash Troughs

Performance Proved in over 375 plants with a daily capacity of more than 2¾ billion gallons!

In this design, laterals and distributing blocks form a permanent unit that assures equal filtration and uniform wash distribution with low loss of head. Made of de-aired fire clay—vitrified and salt glazed—the blocks can't corrode, won't absorb water, are acid and alkali resistant, and are not subject to tuberculation.

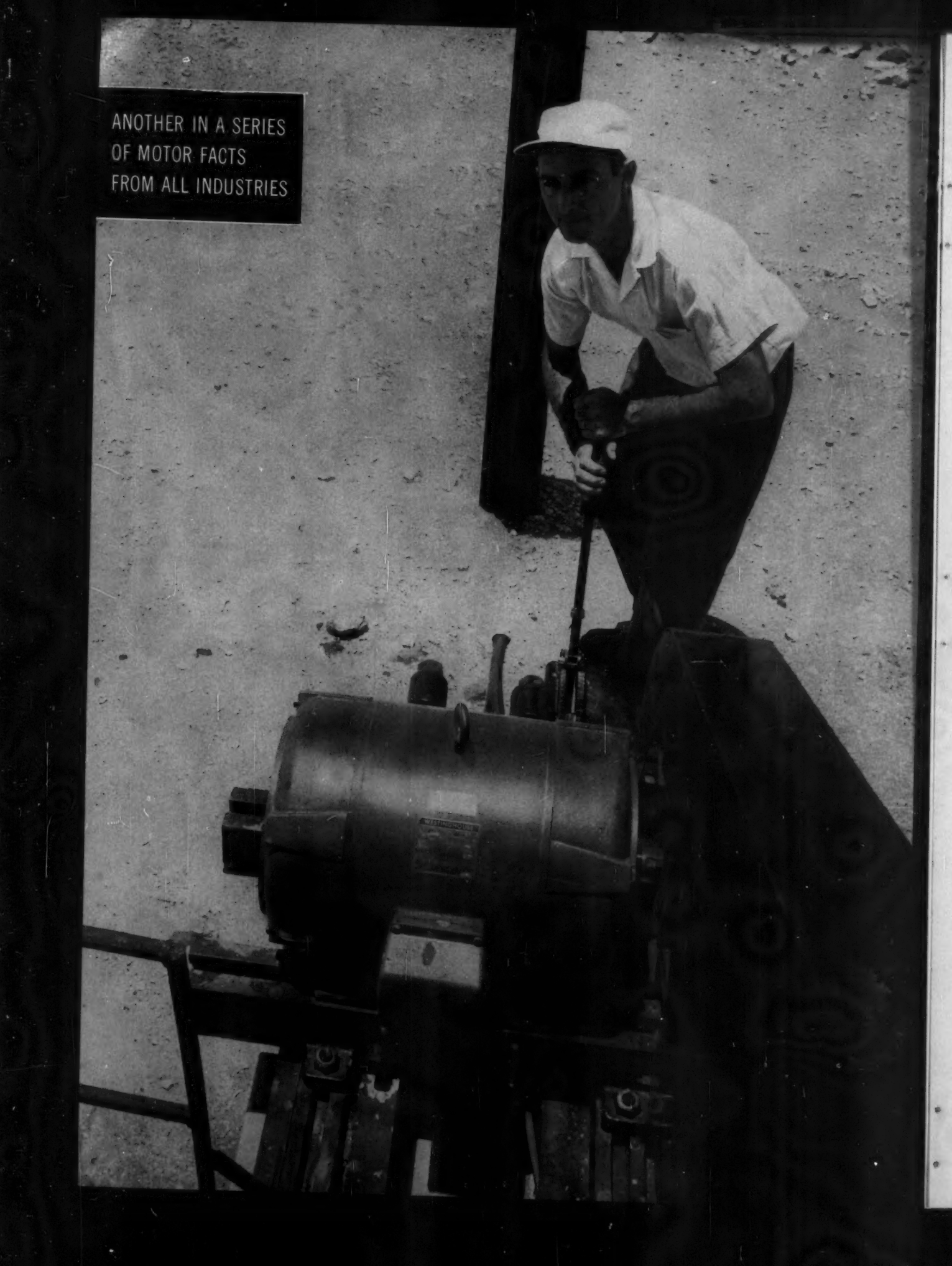
In addition, the Leopold Filter Bottom needs only a shallow depth of small-sized filter gravel, does not require supporting concrete structures, and is the only design providing a fixed and controlled secondary backwash.

*Literature and Complete Details Furnished on Request!*

Leopold

F. B. LEOPOLD CO., INC.
Zelienople, Pa.

COMPLETE WATER PURIFICATION AND FILTER PLANT EQUIPMENT


ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES

Sand... heavy rain... extreme heat...

# Nothing stops These Westinghouse Life-Line A Motors

*dependably driving oil well pumps in Odessa, Texas district of The Atlantic Refining Company, 24 hours per day, 7 days a week!*

"Here's an application," says A. P. Johnston, production engineer at The Atlantic Refining Company, "where we must have continuous motor operation . . . sometimes for as long as 18 months . . . with virtually no maintenance or repair. Many of our pumping stations are remotely located, automatic and unmanned. Any stoppage or motor failure would result in the loss of several hundred barrels of oil. Motor repairs in the field are prohibitive in cost. We must have *complete* motor reliability and that's exactly what we get from our Westinghouse Life-Line® "A" motors."

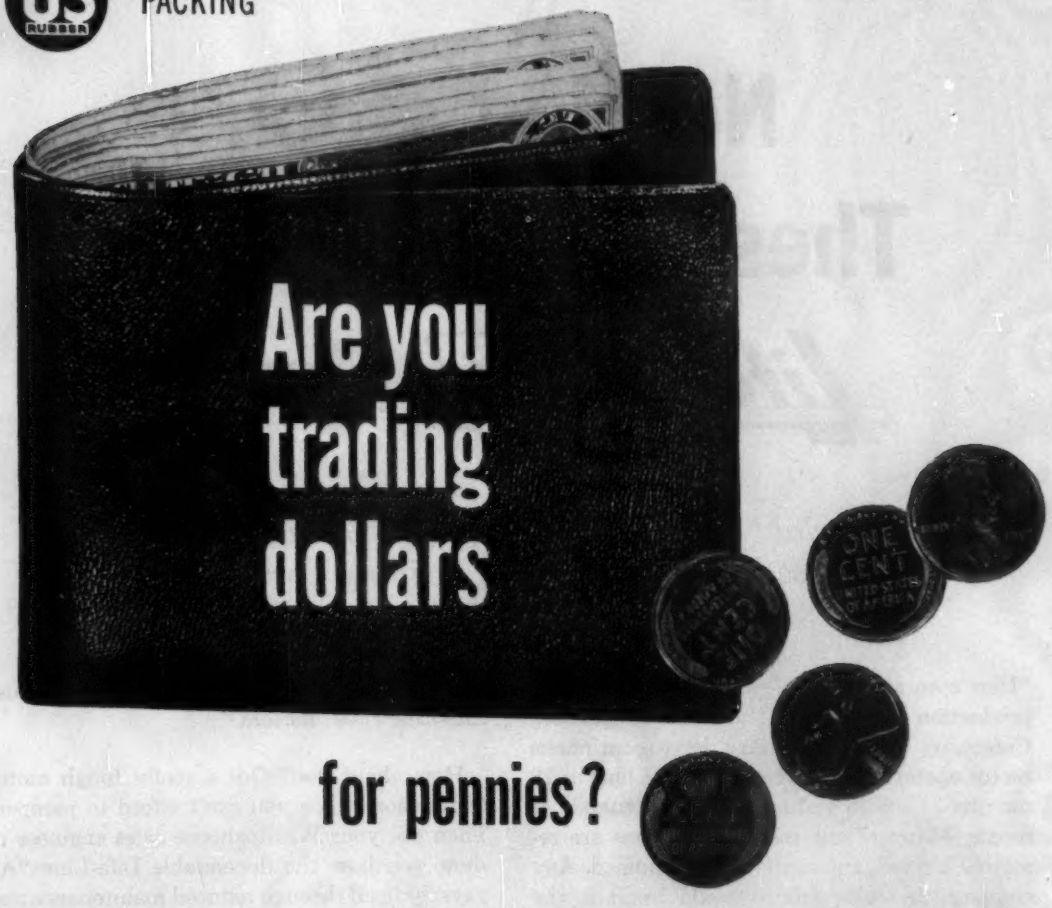
How about you? Got a really tough motor application which you can't afford to pamper? Then ask your Westinghouse sales engineer to show you how the dependable Life-Line "A" pays for itself through reduced maintenance and repair. Or write to Westinghouse Electric Corp., P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

J-22055-R

YOU CAN BE SURE...IF IT'S Westinghouse

On this pumping unit, the 15-hp Life-Line "A" motor operates in an atmosphere of damaging dust, sand and moisture. Despite continuous, heavy-duty service, motor has never suffered any overheating since first installed. Prelubricated bearings of the Life-Line "A" eliminate periodic greasing . . . keep lubricant in . . . dirt out.

US RUBBER PACKING




**You may be. Consider this:** How much does it cost you every time you shut down a production line to replace the packing in just one piece of hydraulic equipment? Now, multiply this by the amount of times this same equipment has had to be re-packed, say, in the past three years. And multiply this figure by the total amount of hydraulic equipment in your production system.

This downtime cost is enormous—just for packing. It's far higher than the cost of the packing itself ...and a lot more than the pennies saved by buying less expensive, inferior packing.

It's for this reason that packing like U.S. Matchless® is, by far, your most economical buy. It's made in a variety of styles, each for specific applications. Used and recommended by many of the leading original equipment manufacturers, Matchless is a packing you can trust to do the job longer, better.... to turn downtime losses into uptime profits.

U.S. Matchless is part of a complete line of quality packings available at your "U.S." Distributor, or write us at Rockefeller Center, N. Y. 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

Mechanical Goods Division

**United States Rubber**

See things you never saw before. Visit U. S. Rubber's New Exhibit Hall, Rockefeller Center, N.Y.

## Men in the Industry . . .

and had previously worked as a development engineer for a soap firm.

In 1942 he was assigned to the Institute, W. Va., synthetic rubber plant being operated for the government by Naugatuck. Four years later he returned to Naugatuck, Conn., and was assigned to the colloidal products sales department for three years. He became assistant manager of colloidal products development, and in 1955 was made assistant manager of synthetic rubber development.

**George W. Sisler** has been appointed advertising manager of the Ashland Oil & Refining Co., Ashland, Ky. Sisler, who has been an account executive in the home office of McCann-Erickson, Inc., since early 1954, will assume his new duties on Feb. 1st with headquarters in Ashland.

**Dr. W. Mayo Smith** has been appointed director of research for the Escambia Chemical Corp.

Dr. Smith has served as assistant director of research in charge of polymerization and plastics research and development since April, 1956.

Escambia's Research and Development activities will be moved late this spring to the new Escambia research center in Wilton, Conn., where Dr. Smith will be in charge.

**Frank O. Prior** has been named chairman and chief executive officer and **John E. Swearingen** president of Standard Oil Co. (Indiana).

Prior has been president since 1955. Swearingen has been an executive vice president since 1956.

In other moves, additional responsibilities have been given to **Robert C. Gunness,** also an executive vice president since 1956; and **George V. Myers,** general manager of production, has been elected vice president for produciton.

Prior becomes the third chairman in the history of Standard Oil, Swearingen the ninth.

Prior joined Midwest Refining Co. in 1919. He later became president of Dixie Oil Co., and in 1930 president of Standard Oil and Gas Co. In 1945 he was elected a director and vice president in charge of production of Standard. He was elected executive vice president in 1951, and president in 1955.

Swearingen joined Standard Oil in 1939 as a chemical engineer in its Whiting, Ind., research laboratories. He transferred in 1947 to Pan American Petroleum Corp. to become a director of that company early in 1951. He came to Chicago late in 1951 as general manager of production for Standard Oil. He was elected a director in 1952, vice president in charge of production in 1954, and an executive vice president in 1956. He received his B.S. degree in chemical engineering from the University of South Carolina, and his M.S. degree from Carnegie Institute of Technology.

Robert C. Gunness received his B.S. degree in chemistry at the University of Massachusetts, and his D.Sc. degree in chemical engineering at Massachusetts Institute of Technology. In 1938 he joined Standard's research department at Whiting, Ind., as a group leader. He became manager of research in 1947, assistant general manager of manufacturing in 1952, and was elected a director in 1953. He became general manager of the new supply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**chemical feeder**
from this **new catalog**

**WHATEVER YOUR REQUIREMENTS** for liquid metering, be sure to get the *exact* unit you need . . . with this new Manzel Chemical Feeder Catalog. It's the most complete, most useful catalog on metering pumps ever published. Gives detailed engineering data, with recommendations for handling *specific* chemicals, acids and other liquids. Thirty-six pages of valuable information designed to help you select the correct proportioning pump. **WRITE FOR YOUR FREE COPY** and take the guesswork out of metering pump selection.

Manzel

A UNIT OF HOUDAILLE INDUSTRIES, INC.

285 Babcock Street • Buffalo 10, New York

*Specialists in metering pumps and lubricators since 1898*




For more data on advertised products, use Readers' Service Cards, last page.

## Men in the Industry . . .

and transportation department in 1954 and an executive vice president in 1956.

George V. Myers came to Standard as general manager of production in March, 1956. He was named a director in October, 1956. He had been financial vice president and a director of Stanolind Oil and Gas Co. at Tulsa. He had joined Stanolind in 1953. Earlier he had been controller of Westinghouse Air Brake Co. at Pittsburgh and a special agent for the F.B.I.

**Morton A. Sterling** has been elected president of Sunset International Petroleum Corp. by the board of directors, it was announced recently. He succeeds **J. D. Sterling**, who was elected to the recently-created position of chairman of the board.

Morton Sterling joined the company in 1946. In 1950, he was named vice president in charge of production and elected to the board of directors. He has been executive vice president since 1955, and a member of the executive committee since 1956.

**William M. Grass** has been appointed assistant purchasing agent for the eastern division of Tidewater Oil Co.

Grass was formerly assistant to the division marketing manager. He replaces **William C. Sander**, who recently retired from the purchasing post.

Grass joined the company in 1924 as a clerk at the New York office. He later became accounting supervisor, assistant to the New York district manager, assistant to the Newark zone manager, accessory sales supervisor and retail sales supervisor. He was appointed assistant New York district marketing manager in 1956 and assistant to the division marketing manager last June.

**B. B. Turner,** president of Ethyl Corp., has been designated chief executive officer of the company.

**Edward L. Shea,** who was formerly chief executive officer, will continue as chairman of the board of directors.

Turner has been president of Ethyl since 1956, prior to which he served as executive vice president. Shea was named chairman of the board in 1956, after serving as president since 1947.

**Arthur W. Langer, Jr.,** has been named a section head in the chemicals research division of the Esso Research and Engineering Co. Langer started his company career soon after he earned a Ph.D. degree in organic chemistry at Ohio State University. He earned B.S. and M.S. degrees in the same field at the University of New Hampshire in Durham.

**H. W. H. Meyer** and P. S. Viles have been promoted to senior research chemists in Research and Development division at Humble Oil & Refining Co.'s Baytown, Texas, refinery. Meyer is engaged in exploratory research, and Viles in long-range research, on fuels processes.

Meyer holds a Ph.D. degree in chemistry from Texas University and Viles a B.S. degree in chemistry from Texas Technological College.

**William K. Creson,** consulting engineer, Ross Gear and Tool Co., Inc., Lafayette, Ind., has been elected president of the Society of Automotive Engineers for 1958.

Creson joined Ross Gear and Tool Co. on his graduation with a B.S. degree in mechanical engineering from Purdue University in 1924. After eight years, he had full responsibility for tooling equipment and maintenance. Then followed 11 years as a chief engineer, and 11 years as vice president of engineering. His request for relief from administrative duties was granted in 1954. Since then he has served Ross Gear and Tool as consulting engineer.

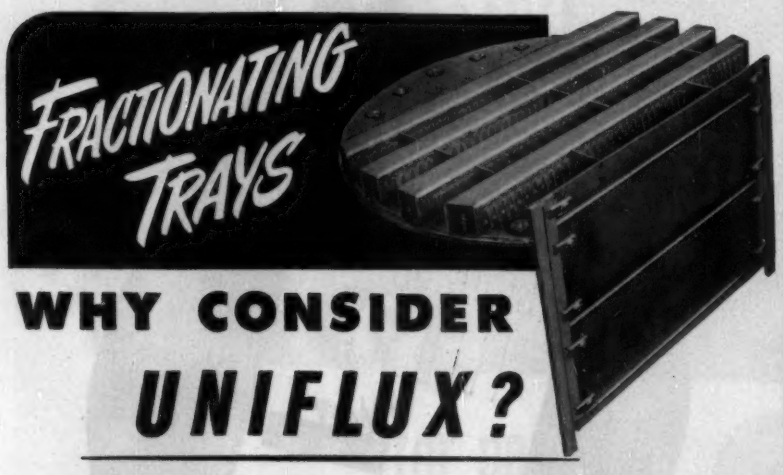
**John D. Wells,** a chemical engineer with a B.S. degree from Lafayette College, has been appointed a senior staff engineer in the engineering coordination unit of Esso Research and Engineering Co.

Wells has been with Esso Engineering 15 years. In his new assignment, he is responsible for the staff engineering work for affiliates in Cologne and Hamburg, Germany, and Rotterdam in The Netherlands.

**L. L. Whiteneck,** vice-president and director of materials research for Plicoflex, Inc., Los Angeles, Calif. has been elected president of the National Assn. of Corrosion Engineers. He will take office on the last day of the Annual Conference and Exhibition in San Francisco.

Also elected were **Hugh P. Godard,** head of the chemical division, Aluminium Laboratories, Ltd., Kingston, Ontario, Canada, vice-president and **A. L. Stegner,** corrosion engineer for Tennessee Gas Transmission Co., Houston, reelected for a second term as treasurer.

Before joining his present employer,


WHY CONSIDER UNIFLUX?

FOR LOWER COST? . . . . . YES!
(25% to 50% Lower)

FOR COMPARABLE CAPACITY? . . . . YES!
(Equal or Better Than Conventional Designs)

FOR HIGHER EFFICIENCY? . . . . . YES!
(Closer Approach to Equilibrium)

FOR MAXIMUM FLEXIBILITY? . . . . YES!
(Wide Operating Range)

FOR MINIMUM MAINTENANCE? . . . YES!
(Simplified Installation, Self-Cleaning Characteristics)

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MISCO FABRICATORS, INC.
Designers, Builders, Fabricators of Heat Resisting Alloy and Stainless Steel Equipment
2420 WILLS AVENUE • MARYSVILLE, MICHIGAN
TELEPHONE: YUKON 5-6191




For more data on advertised products, use Readers' Service Cards, last page.

This huge B&W draw bench for the production of Hollow Forgings is capable of taking a 26,000 pound pierced ingot.

# B&W Hollow Forgings —for piping economy in heavy-duty service

Petroleum and power engineers have found a solution of their piping problems at B&W. They save time and money by specifying high-quality B&W Hollow Forgings that have been produced under carefully controlled conditions from initial electric furnace melting through final inspection. B&W production techniques include uniform and thorough working of the ingot, which result in excellent forging properties.

Piping is being supplied in a wide range of fractional sizes and a selected range of standard pipe sizes in carbon, intermediate Croloy and stainless Croloy steels.

For additional information, write for Bulletin S-16. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio. S-474-HF

Ask for this BULLETIN: S-16

BABCOCK & WILCOX

BOILER DIVISION



For more data on advertised products, use Readers' Service Cards, last page.

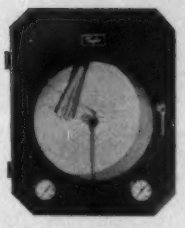
# 20 *Years the Standard of Control—*
# TAYLOR FULSCOPE® CONTROLLERS

**1** ***DEPENDABILITY*** Many FULSCOPE Controllers have been in continuous operation for twenty years or more, with practically no major service required.

**2** ***ADAPTABILITY*** The basic control mechanism can be changed from the simplest to the most complete form, and to the measurement of any variable—in either recording or indicating models.

**3** ***LOW MAINTENANCE*** In addition to being rugged and dependable, the FULSCOPE Controller is unusually easy to understand and simple to service.

**4** ***ECONOMY*** The few extra dollars for FULSCOPE quality are paid off by many extra years of trouble-free performance.

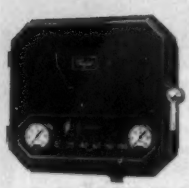


**FULSCOPE RECORDING CONTROLLER** is a versatile instrument for accurate recording and automatic control of one or two variables. It is completely adaptable to practically any control problem through the interchangeability of response forms: **Adjustable Sensitivity** for throttling control on applications with a wide range of time lags and capacities; **Automatic Reset** for precision control on applications involving a wide range of time lags and capacities, with gradual, sustained load changes; **Pre-Act*** derivative response for applications with a wide range of time lags and capacities, with sudden, momentary disturbances, but without sustained load changes. **Any combination of these responses may be had in single or double duty form.**

**THE PNEUMATIC SET CONTROLLER** is a single duty FULSCOPE Recording Controller in which the set pointer is automatically adjusted by a pneumatic signal from any external source. This reduces the effects of process lag and results in better control—e.g., flow is frequently controlled in direct ratio to another flow or liquid level.

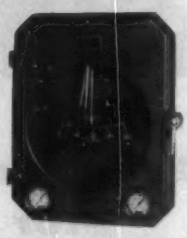
**THE RATIO CONTROLLER** controls one variable—temperature, pressure, flow, or liquid level—in direct or inverse ratio to some other related variable, and records the adjusting variable. Wide range of ratio adjustments can be made directly on the calibrated dial.

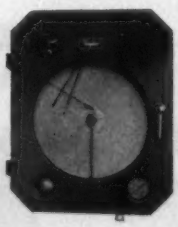
## Pick the FULSCOPE CONTROLLER that fits your process requirements . . .



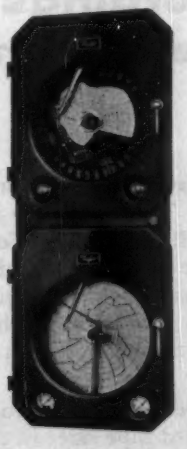
**INDICATING CONTROLLER** is the simplest form of the FULSCOPE Controller. Wherever a record is not important, this instrument will give satisfactory service as a moderately priced indicating controller for temperature, pressure, flow, or liquid level. It maintains these effects at a constant level, by increasing or decreasing the service that controls them.

**An exclusive feature** of the FULSCOPE Indicating Controllers is the availability of 2 complete control systems encased in the standard recorder-size case.
(See instrument at right.)





**RECORDING CONTROLLER WITH PROCESS TIMER** is essentially the same instrument as the FULSCOPE Recording Controller, except that it begins timing the process when the controlled variable reaches the proper point, and turns the process off after a predetermined length of time.



**THE TIME SCHEDULE CONTROLLER** is a FULSCOPE Recording Controller which will exactly repeat a predetermined program involving time with temperature, pressure, flow, or liquid level. One or two large, chart-size cams are cut to determine the optimum value of the controlled variables at each point in the process time. The instrument set pointer is varied continuously by the progress of the cam follower over the cam contour. A variation of this instrument is the FULFLEX* Time Schedule Controller which has all control adjustments on the front of the case, permitting changes during the process, as commonly required in textile dyeing processes.

*Ask your Taylor Field Engineer for further information, or write Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario.*

*Trade-Mark

**Taylor Instruments MEAN ACCURACY FIRST**

Whiteneck was with the Long Beach, Calif., Harbor and Water departments for many years working on corrosion control projects, and is now NACE vice president.

Godard, whose main work for the past 12 years has been in corrosion reactions of aluminum, has been an NACE director and a member of the abstract and technical committees. He is a former chairman of the NACE Inter Society Corrosion Committee and has been a member of the Canadian Associate Committee on Corrosion Research since its inception in 1947, among other organizations in Canada.

A. L. Stegner belongs to several organizations in the petroleum industry concerned with corrosion control. He has been active in NACE as a director and in other capacities.

**L. T. Vice** has been named a vice president of California Commercial Co., subsidiary of Standard Oil Co. of California. He will direct the firm's Washington, D. C. offices.

Vice succeeds **Woollen H. Walshe** who will be senior attorney for the California company, with offices in New Orleans.

An engineering graduate of Stanford University, Vice joined Standard in 1934 as an oil field employee. In 1951 he was named special representative for government contract work in Washington.

Prior to his new assignment, Vice was chief engineer for manufacturing and sales in the El Paso office of Standard Oil Co. of Texas.

**Walter H. Rupp,** a graduate of the University of Pittsburgh, has been appointed a senior staff engineer in the engineering coordination unit of Esso Research and Engineering Co.

Rupp began his Esso engineering career in 1930 as a design engineer. He holds numerous patents and is the author of a number of publications in the field of general refining and air pollution.

In his new assignment, Rupp is responsible for the staff engineering activities for affiliates in Aruba, Cuba, and South America.

**A. C. McKinnis** has been named research associate in the Chemical Research division at Union Oil Co. of California's research center, Brea, Calif.

**Orville L. White,** a mechanical engineer with a B.S. degree from the University of Kentucky, has been appointed a senior staff engineer in the engineering coordination unit of Esso Research and Engineering Co.

In his new assignment, White is handling the staff engineering work in connection with Esso Standard Oil Co's. refinery in Baton Rouge, La., and refineries of Carter Oil Co. and Humble Oil & Refining Co. and Imperial Oil, Ltd., in Canada.

**John D. Wells,** a chemical engineer with a B.S. degree from Lafayette College, has been appointed a senior staff engineer in the engineering coordination unit of Esso Research and Engineering Co.

Wells has been with Esso Engineering 15 years. In his new assignment, he is responsible for the staff engineering work for affiliates in Cologne and Hamburg, Germany, and Rotterdam in The Netherlands.

**J. C. Alspaugh** has been promoted to assistant superintendent of the butadiene plant, **T. C. Smith** to foreman of the Utilities department, and **J. D. Robertson** to assistant foreman of the Compound and Package department at Humble Oil & Refining Co.'s Baytown refinery.

Alspaugh attended Texas Christian University and Vanderbilt; Smith and Robertson hold B.S. degrees from Louisiana State University, in electrical engineering and in engineering, respectively.

**Charles E. Spahr** has been elected president of The Standard Oil Company (Ohio), succeeding **Clyde T. Foster,** who continues as chairman of the board and chief executive officer.

Spahr has been executive vice president and Foster both chairman and president. Spahr has been with Ohio-Standard since October, 1939, except for four years during World War II, when he supervised construction of one of the two major pipe lines in the India-Burma theater of operations.

## Men in the Industry . . .

### DEATHS

**William M. Irish, Jr.,** 89, former president and director of The Atlantic Refining Co., died recently while vacationing in St. Petersburg, Fla.

Irish had been associated with Atlantic for 46 years before his retirement in 1937. He became a director in 1905 and in 1911 was appointed secretary. In 1915 he was elected a vice president and from 1927 to 1937 served as president of the firm.

A native of Fair Haven, Mass., he graduated from Cornell University in 1890. He is survived by his wife and two children.

when dependability counts
look to DEAN HILL
designers and producers
of fine pumps and turbines

Since 1893 Dean Hill has produced quality pumps and turbines for the petroleum, chemical and hundreds of other industries both in the U.S. and abroad. Long service and reliable performance have made the name Dean Hill symbolic of quality in design and construction.

DEAN HILL PUMP COMPANY
*Pump and Turbine Engineers Since 1893*
Indianapolis 7, Indiana

SALES OFFICES IN PRINCIPAL CITIES




For more data on advertised products, use Readers' Service Cards, last page.

# Looking for cost leaks? Look at your steam traps

## Engineering approach to steam trapping can save thousands a year on costs of fuel, trap maintenance, process cycle time, and uniformity of product quality

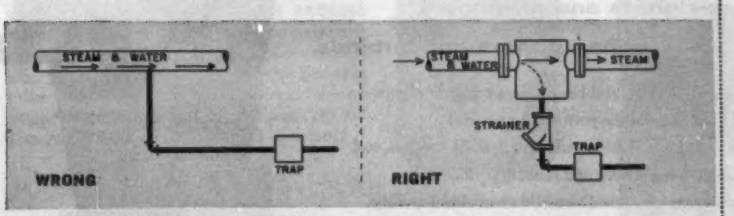
Plant and process engineers all across industry have found that Sarco *Production-Planned* steam trapping can pare operating costs by thousands of dollars a year.

*Production-Planned* steam trapping is an engineering approach to the problem of getting full design values of heat transfer from steam using equipment. Scores of case histories show that it can make substantial savings and improve processing efficiency. At the same time, costly trap maintenance can be greatly reduced.

In Sarco *Production-Planned* steam trapping, traps are matched to the job by *type* as well as size. They are properly placed, correctly installed. And, to keep down maintenance and replacement costs, every trap is top-quality.

It may pay you well to take this engineer's-eye view of *your* steam trapping. And why not have a Sarco representative look over your system with you? His suggestions will be completely objective because Sarco—and only Sarco—makes a steam trap for every basic requirement. Quality? Recognized everywhere for half a century.

## Production-planned systems make best use of traps




As the two illustrations above show, correct application of steam traps is as necessary as using the right trap. In the hook-up on the left, the lack of a condensate collection point plus the long leg to the trap will result in condensate's flowing past the drain point, possibly causing water hammer. The correct way to install the trap is shown at right, placed close to the drain point. A *strainer* should be placed before *any* trap to prevent entrance of scale or other foreign matter into the trap.

This is just one example of the way your Sarco representative can help you plan your steam system for maximum production.

## Traps must be matched to job for best system performance

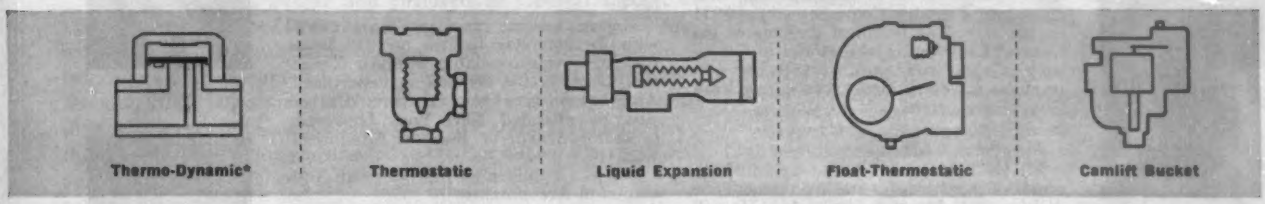
No single type of steam trap will perform well in all applications. Each type has a range of applications for which it is best suited. For optimum efficiency these differences must be taken into account; traps must be chosen for their operating principles as well as their size and pressure rating.

Sarco can give you impartial help in selecting traps because only Sarco makes the five basic types. With Sarco, it's simple—one source, one responsibility, for all your trapping needs.



For more data on advertised products, use Readers' Service Cards, last page.

## Only Sarco makes these five basic types of steam traps




5579

**Take these two steps to Production-Planned steam trapping:**

(1) Write today for Sarco literature; (2) Talk with your Sarco representative. He can help you check your trapping requirements, and he has—or will quickly get—the right answer to any unusual trapping problem.

*T.M. U.S. Pat. No. 2,817,353

**SARCO**
**COMPANY, INC.**
635 Madison Ave., New York 22, N. Y.



For more data on advertised products, use Readers' Service Cards, last page.

# What Suppliers Are Doing . . .

Roberts

**Wilbur S. Roberts, Jr.,** has been appointed manager of the New Business division of Stone & Webster Engineering Corp.

Roberts will coordinate the new business activities of the New York and Boston engineering and construction company's offices in Chicago, Houston, Los Angeles, San Francisco and Seattle.

A Union College (Schenectady) business engineering graduate, Roberts, during World War II, was loaned to the War Production Board in Washington. From 1949 through 1953 he was assigned to Britain where Stone & Webster was erecting a petroleum refinery.

Dressel

**Ed L. Dressel,** of the Tretolite Co. division of Petrolite Corp. development laboratory in St. Louis, Mo., has been assigned to head the company's new field service laboratory recently completed at Odessa, Texas.

Dressel served for five years in the company's research department where he was concerned with work on corrosion inhibitors. For the past two years he has helped in carrying out the company's service and development laboratory program.

Gooch

**Cornelius S. Gooch** has been appointed a service engineer for the Dallas office of B-I-F Industries, Inc., and will assist in the installation and servicing of the company's line in that area.

Gooch received his A.B. degree in science and engineering from the University of the South, and thereafter ran his own engineering company in Amarillo for ten years. His engineering experience includes service with Braniff Airways and with the technical staff of the Defense Supplies Corp., and several years in Brazil as a project manager for the Otis Elevator Co. Previously he was a division manager of the Lewis Dodson Engineering Co. of Dallas, a B-I-F distributor.

Bigelow

**C. Glen Bigelow, Jr.,** has been appointed to the newly-created position of director of research for Selas Corp. of America.

Bigelow's background includes specialization in the building of heavy industrial furnace equipment and automatic heat treating machinery.

He joined Selas from American Machine and Foundry Co., where since 1951 he has served as technical director of the General Engineering laboratories in Greenwich, Conn., and more recently as new products secretary in the firm's New York City headquarters.

Schelbe

**W. D. Schelbe** has been appointed director of purchases for the Wolverine Tube division of Calumet & Hecla, Inc. He will be responsible for coordinating the purchasing activities of Wolverine's plants in Detroit, Michigan, Decatur, Alabama, and the company's London, Ontario mill. Schelbe will make his headquarters at the division's executive offices in Allen Park, a suburb of Detroit. He was previously assistant purchasing agent at the Detroit plant, purchasing agent of the Decatur plant and assistant director of purchases for the division.

**Glenn H. Fitch** has been named sales manager of Mirror Insulation Co., Lambertville, N. J. Initially, Fitch will concentrate his activities in the Eastern markets.

He formerly served in industrial sales with Baldwin-Hill Co., Trenton, N. J., where he was sales manager of the East Coast division and district manager of the Chicago and Cleveland sales districts. Prior to that he spent nine years with the Aluminum Co. of America, including five years in sales. He received his B.S. degree in general engineering at Iowa State College.

Fitch

**Raymond J. Kenard, Jr.,** has been named sales representative in Selas Corp.'s Los Angeles sales district.

Kenard will concentrate his activities in California, Utah, Arizona and Nevada and will also assist **S. A. Whitehurst** in serving industries where Selas heating equipment is used.

Kenard obtained his B.S. degree in chemical engineering at Pratt Institute, and joined Shell Oil Co., where he was refinery technologist in the Houston and Wilmington, Calif. refineries and New York headquarters. Previously he was with Union Iron Works of California, Los Angeles, as a sales engineer.

Kenard

**George F. Hornaday** has been named manager of the Research and Development division of Houdry Process Corp.

Hornaday, who had been associate manager of the division since December, 1956, heads operations at the Linwood, Pa., Research and Development laboratories of Houdry. Before that, he was assistant process sales manager of the company.

Prior to joining Houdry in 1940 as assistant manager of development, Hornaday was with the then Socony Vacuum (now Socony Mobil) Oil Co. His experience includes catalytic cracker operation, reactor design, technical service, and participation in development of the Houdry Dehydrogenation Process.

Hornaday received his B. S. degree in chemical engineering at Purdue University.

Hornaday

**Vincent T. Nolan** has been appointed purchasing agent of the Alloy Tube division of The Carpenter Steel Co., Union, N. J.

Nolan, former chief accountant and with the company for the past 15 years, previously was associated with Air Reduction Corp. in the accounting department. After graduating from Rutgers University, he attended New York University Graduate School of Business Administration.

He is a member of the National Association of Accountants.

Nolan

**L. B. Rainey, Jr.** has been appointed assistant manager, Project Sales department, Jones & Laughlin Supply division. Rainey has been with Jones & Laughlin Steel Corp. in various sales capacities at Pittsburgh for the past 22 years. He graduated from Dartmouth College in 1936 and joined J&L in the same year. He is a member of the American Petroleum In-

Rainey

# GIANT Turbine Expansion Joints Built by BADGER

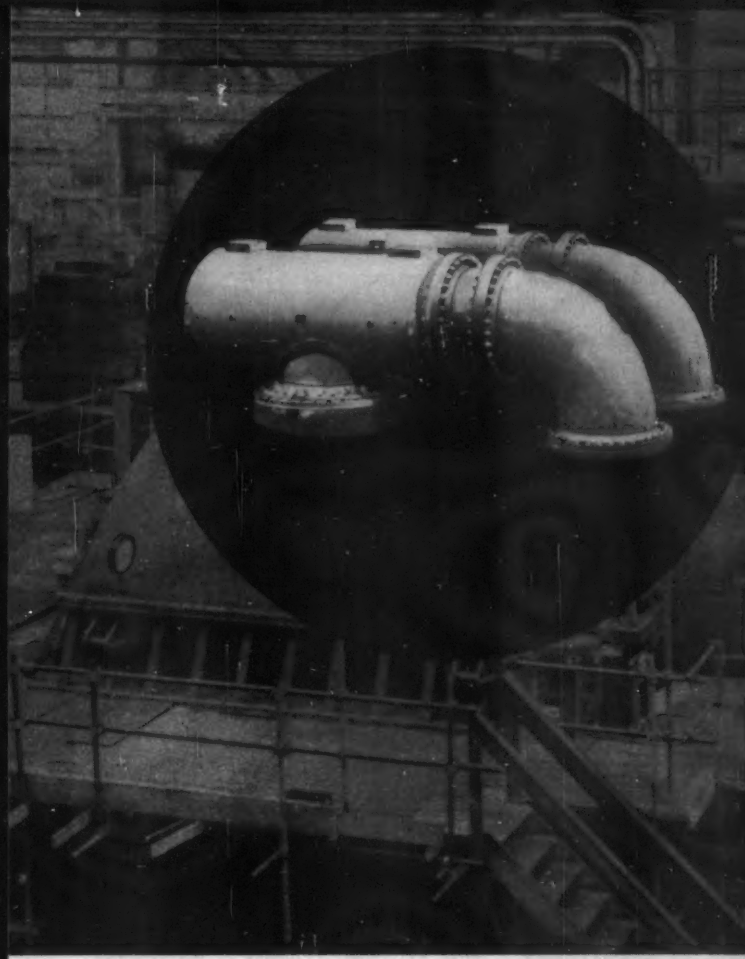
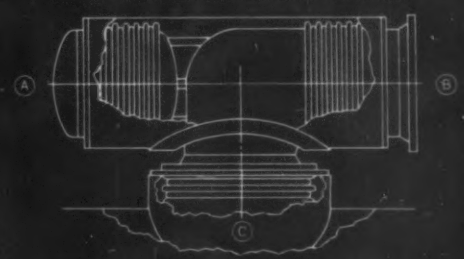


Photo shows 150,000 kw steam turbine-generator unit undergoing tests prior to shipment at General Electric's Turbine-Generator Plant in Schenectady, N. Y. Badger Expansion Assembly is clearly visible atop turbine.

Badger balanced elbow expansion assembly.




Joint A balances thrust due to internal pressure of 65-150 psi; joint B absorbs axial movement; joint C absorbs the differential expansion between the inner and outer casings of the turbine. Assemblies range in size from 36 to 42 inches in diameter.

## Custom engineered assemblies include many features of Badger S-R Design

750°F steam is flashed through these turbine crossovers at speeds up to 150 ft/sec and pressures up to 150 psi.

How do you protect piping and turbine casings from the stresses of extreme internal pressure and the expansion such temperature is bound to produce?

Working together, Badger and engineers at General Electric's Large Steam Turbine-Generator Department solved the problem with a new type pressure balanced elbow expansion assembly. Using two separate joints mounted in a T-shape casing (see diagram) the assembly effectively absorbs and controls axial movement. Although the device was custom engineered to General Electric's requirements, the bellows elements are constructed to the Curvilinear Corrugation design recently announced by Badger and now used in all S-R Expansion Joints.

Whether you need standard S-R Expansion Joints or custom equipment, Badger can serve your needs. Get more information — write for illustrated brochure today.

### *New corrugation and ring designs produce better equalization, "all-curve" flexing*

Curvilinear Corrugations used in S-R Expansion Joints were developed by the Badger Research Department. Under operating pressures (white line) the new design produces more uniform movement per corrugation and natural "all-curve" flexing. Stress is reduced . . . life increased.

Series 50 corrugation cross-section

S-R Joints for higher pressures have tubular Reinforcing Rings. These new rings make metal-to-metal contact only in the "valley" of each corrugation allowing natural "all-curve" flexing (white line). Tubular shape permits greater effective flexing height which contributes to longer life.

Series 150 corrugation and ring cross-section

**BADGER**

**S R**

SERVICE RATED

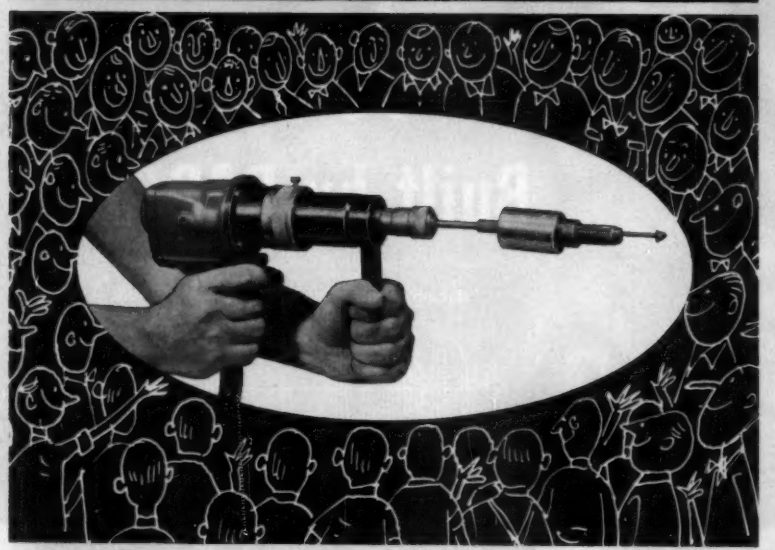
**EXPANSION JOINTS**

© 1958 BMC

**BADGER MANUFACTURING COMPANY**
230 Bent St., Cambridge 41, Mass. • 60 East 42nd St., New York, New York
*Representatives in Principal Cities*

# The New ELLIOTT Air Magnetic Control...

*for tube expanding in hazardous locations*



## popular everywhere!

*here's why:*

- faster-rolling
- higher maximum torque
- simpler to use and maintain
- and costs are low

These advantages have made the Elliott air magnetic control the popular choice of operators in oil refineries, chemical plants, and other industries. Its secret is a uniquely-engineered design which uses a new concept of torque control. Two powerful permanent magnets give instantaneous engagement and disengagement between air motor driver and driven expander. Calibrating dial permits exact settings for torque control.

Four types of expanders available for tubes ¼ in. through 3 in. *Write for data today.*

**ELLIOTT Company**

LAGONDA PLANT, SPRINGFIELD, OHIO

Headquarters for Tube Cleaners and Expanders


## Suppliers . . .

stitute and the American Iron & Steel Institute.

Link

McCauley

**SHAND AND JURS CO.** has announced the election of **Edwin A. Link** and **Bruce McCauley** to the board of directors. Link is the founder and chairman of the board of Link Aviation, Inc., and McCauley's election is from his position as vice president of Finance for Shand and Jurs. He will continue in this capacity, while assuming new duties and responsibilities as a Director.

Link's election closely follows his recent election as vice chairman of the board of General Precision Equipment Corp., of which Shand and Jurs Co. is a subsidiary. The originator of aerial trainers and simulators, Link received the U. S. Air Force's highest civilian acclaim, the Exceptional Service Award, in 1954, and is currently a representative of the Joint Panel of Test and Training Equipment of the Guided Missiles Committee Research and Development Board.

Bruce G. McCauley joined Shand and Jurs Co. one and one-half years ago, bringing to his position of vice president of Finance a background in engineering, teaching, and business management. His undergraduate studies in engineering were at the University of Missouri and Yale University. Graduate work at the University of California in Berkeley earned him M.S. degrees in Industrial Engineering and Business Administration. His former business history includes service with the Curtis Manufacturing Co., St. Louis and the Standard Oil Co. of California, and six years of teaching in Berkeley at the University of California's College of Engineering. About 5 years ago McCauley established his own firm of consulting management engineers.

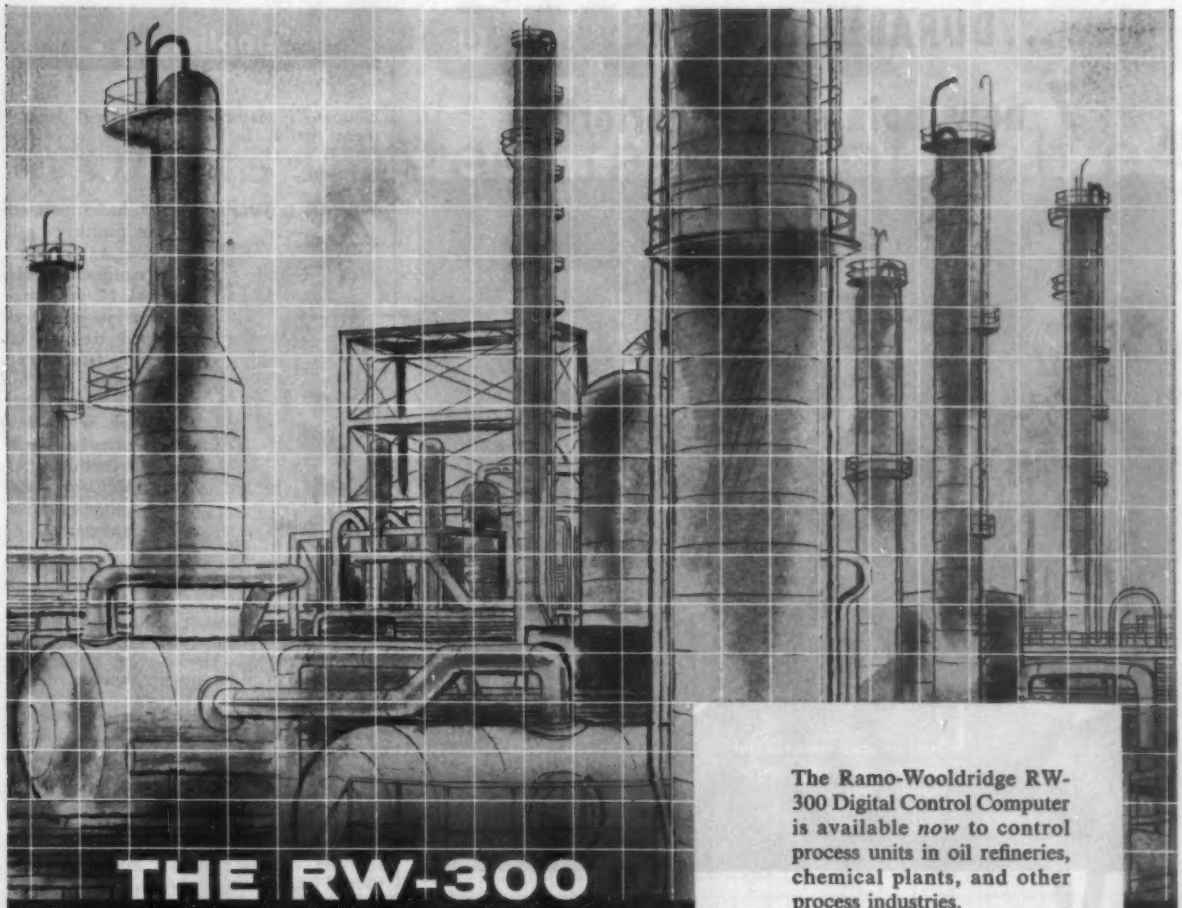
**THE INDUSTRIAL EDUCATION INSTITUTE,** in cooperation with leading professional societies, trade associations and industrial publications, will sponsor two one-day seminars on applying statistical analysis to experimentation. The seminars will be conducted by **Westinghouse Electric Corp.** experts who have developed, applied and taught these procedures throughout their company.

These seminars are designed to demonstrate practical, proven techniques for preplanning all experiments on an objective, scientific basis. Those who attend, will learn how to eliminate the time and money consuming method of investigating variables one at a time.

The Westinghouse seminar leaders will be **William H. Horton,** manager of experimental design and statistical analysis of the

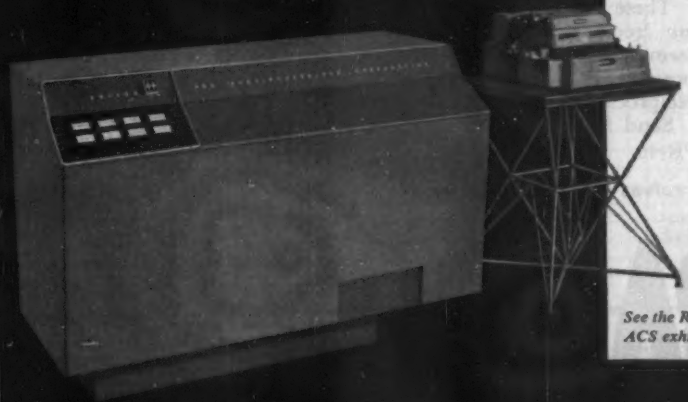


For more data on advertised products, use Readers' Service Cards, last page.



# THE RW-300

is the first digital computer for automatic process control and data logging



The Ramo-Wooldridge RW-300 Digital Control Computer is available *now* to control process units in oil refineries, chemical plants, and other process industries.

The new RW-300 offers outstanding opportunities for higher profits from existing and future plants—through reduced operating costs, increased throughput and yields, and improved product quality. These benefits will pay back an investment in an RW-300 digital control system within six months to two years.

For technical information on automatic process control and advanced data logging with the RW-300, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P.O. Box 45067, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

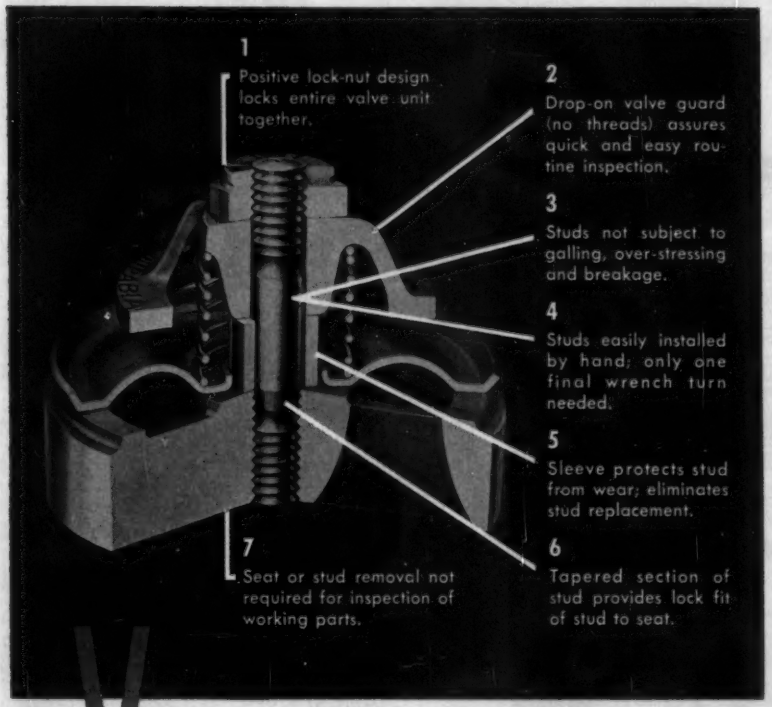
*See the RW-300 in operation at the ACS exhibition, April 13-17, San Francisco.*

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY



For more data on advertised products, use Readers' Service Cards, last page.

# Now...DURABLA Pump Valves offer 7 new points of superiority!


1
Positive lock-nut design locks entire valve unit together.
2
Drop-on valve guard (no threads) assures quick and easy routine inspection.
3
Studs not subject to galling, over-stressing and breakage.
4
Studs easily installed by hand; only one final wrench turn needed.
5
Sleeve protects stud from wear; eliminates stud replacement.
6
Tapered section of stud provides lock fit of stud to seat.
7
Seat or stud removal not required for inspection of working parts.

## New V-design assures even greater dependability

You want *maximum valve dependability* for your reciprocating pumps . . . and DURABLA gives you just that in the new V-7 unit.

Incorporating seven points of superiority, the new valve features a tapered or V-shaped stud which screws down tight to the seat. This exclusive design anchors the stud, eliminating any possibility of galling, over-stressing or breakage. What's more, the new self-locking nut and drop-on guard assure quick and easy inspection of working parts—without stud or seat removal.

Remember: In the DURABLA Valve, only "point contact" is made by the valve member on the stud sleeve, so it can't bind or hang-up. The open-type guard assures free flow of liquid, prevents clogging.

These stainless-steel valves operate freely under temperature extremes, with corrosives, and in any position. Made in 15 sizes to fit any reciprocating pump, old or new.

Send for *NEW* 8-page booklet PR-48.

***Keep your pumps fit with the valves that fit all pumps.***

DURABLA®

DM-26

**DURABLA MANUFACTURING COMPANY**

**114 Liberty Street • New York 6, New York**


## Suppliers . . .

company's materials engineering department; and **R. L. Brickley**, manager of statistical control of the semiconductor department.

**WILLIAM C. BUCHANAN CO.** has appointed **George Smith** to sell the company's Metalab equipment. He has had 11 years experience in the layout and design of laboratory furniture for schools, colleges and industry. Smith will work with **Bob Kirby**, previously a research chemist, and **E. W. McElroy**, field service representative for the company.

Smith

**UNITED STATES STEEL CORP.** has transferred **Christopher H. Marshall** from the company's Oil Well Supply division to Valley View, Alberta, Canada.

**Peter H. Tveskov** will be assistant district engineer-machinery sales and service for the Oil Well Supply division at Odessa, Texas.

**Gene E. Hatton**, field representative of the Oil Well Supply division at Beaumont, Texas, has been transferred to New Iberia, La.

**PUROLATOR PRODUCTS, INC.** has given **Jules P. Kovacs**, vice president in charge of research and development, the responsibilities of new product marketing and special engineering services.

Kovacs joined Purolator in 1929 as a design engineer. He became assistant chief engineer in 1935 and chief engineer in 1940. In 1950 he was named vice president of the company.

**PRESSED STEEL TANK CO.** has named **W. L. Killen** vice president of Downington Iron Works, Inc., a division of the company.

Killen

Killen has been general manager of Downington. He joined the company in 1955 as works manager and has had more than 20 years experience in heavy plate fabrication, including sales and administration.

Killen will be responsible for over-all operation of the Downington division. He is a graduate of the Lewis Institute and the University of Chicago.

**UNITED STATES STEEL CORP.** has appointed **George M. Thursby** administrative vice president, employee relations, and **R. Heath Larry** administrative vice president, labor relations.

Thursby received his education in Pittsburgh and at Duquesne University. He began his career with U. S. Steel in 1921 with the National Mining Co. He became assistant secretary of H. C. Frick Coke Co. in 1939. In February, 1944, he was appointed director of industrial relations for Frick and Associated Coal Cos. and was made vice president, industrial rela-



For more data on advertised products, use Readers' Service Cards, last page.

# POWELL

## world's largest family of valves

Fig. 512—Small Bronze Gate Valve for 150 pounds W.S.P. Inside screw non-rising stem. Solid wedge disc. Can also be supplied with flanged ends.

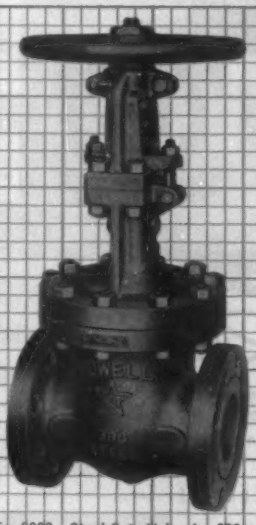


Fig. 3003—Steel Gate Valve for 300 pounds W.S.P. Outside screw rising stem and yoke. Solid wedge Disc, screwed-in seat rings. These valves also available for 150 pounds and higher pressures.

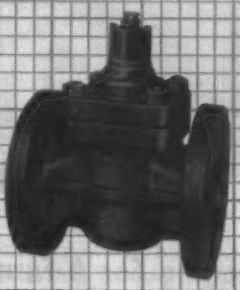


Fig. 2201—Semi-steel Lubricated Plug Valve for 175 pounds W.O.G. Single gland type. Sizes 1" to 4". Can be supplied with screwed ends. Other types and higher pressure valves are available.

Fig. 1793—Large Iron Body Bronze Mounted Gate Valve for 125 pounds W.S.P. Outside screw rising stem and yoke. Solid wedge disc.

Fig. 1561A—New Steel Swing Check Valve for 150 pounds W.S.P. When disc is in wide open position straight, unobstructed flow area through the valve is provided.

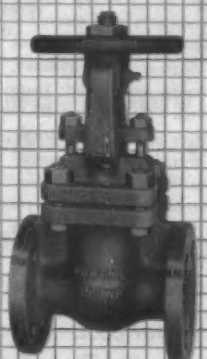


Fig. 2491—Small Stainless Steel Gate Valve for 150 pounds W.P. Outside screw rising stem and yoke, solid wedge disc. Can be supplied with interchangeable double wedge discs. Available also with screwed ends.

**NO MATTER WHAT** your flow control requirements, Powell offers more kinds or types of valves, available in the largest variety of metals and alloys. Powell distributors, located in all principal cities, maintain inventories to fill almost any need. For special engineering problems, write direct to:

**THE WM. POWELL COMPANY** • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**



For more data on advertised products, use Readers' Service Cards, last page.

PUT READY COOL® IN YOUR *Maintenance Picture!*

## Air Conditioning For A Furnace? *Ridiculous!*

**Now stop and think a minute. Couldn't you often use a high velocity of cold air to speed cooling of heated vessels? A 60 Ton* entirely portable READY COOL produces 18,000 CFM of air 25 to 30 degrees below ambient temperature even on the hottest summer days at an operating cost of 26¢ per ton/hour.**

### RESULTS ARE AMAZING!

**CASE I** One large petrochemical plant in East Texas was dissatisfied with the 70 hours lost in cooling down their cracking heaters for maintenance and repair, and secured a 50 Ton READY COOL. The unit was used as a blower until 600 degrees F. was reached, then the air conditioning was added. There was no brick spalling. The cooling down period was reduced to 20 hours average. Worker efficiency was increased approximately 85% working in 75 degrees instead of 120. ***They reported the heaters were repaired and back on stream in less time than previously required for cooling alone.***

**CASE II** Another Chemical Plant said their cooling down time was reduced from 48 hours to 8½ using a READY COOL.

**CASE III** A third Plant stated their payroll was reduced an average of 40% in hot areas where they used their 40 Ton model and that, with less down time, *it paid out each time they used it.*

**FIGURE YOUR OWN SAVINGS**

ADD
A. Present cooling down time ____ Hrs.
B. Average work time in Unit ____ Hrs.
TOTAL ____ Hrs.

MULTIPLY
Down—time loss per hour ____ Hrs.
$____ Hrs.

PLUS
C. PAYROLL FOR MAINTENANCE $____ Hrs.
TOTAL COST $____ Hrs.

The Savings with READY COOL will be approximately 60% of this figure. (75% of "A"; 40% of "B" & "C")

* $6,900 FOB New Orleans, La. Patents Pending

READY COOL® INC. PORTABLE ICE AIR CONDITIONERS

2301 American Bank Building
New Orleans, Louisiana

| Model | #5820 | #5830 | #5840 | #5850 | #5860 |
|---|---|---|---|---|---|
| Tons of Refrigeration | 20 | 30 | 40 | 50 | 60 |
| C.F.M. | 6,000 | 7,500 | 12,000 | 15,000 | 18,000 |
| BTU Per Hour Capacity | 240,000 | 360,000 | 480,000 | 600,000 | 720,000 |

All Units Trailer Mounted; Gasoline or Electric Powered


## Suppliers . . .

tions of the coal companies in June, 1947. He was appointed vice president, industrial relations administration of United States Steel Corp. in July, 1953.

Larry received his B.A. degree at Grove City College in 1934 and his LL. B. at the University of Pittsburgh in 1937.

The appointment of **Paul B. Norton** as district representative at Houma, La., for the Oil Well Supply division of U. S. Steel was also announced.

Norton was employed by "Oilwell" in 1954 at Brookhaven, Miss., and was appointed field representative there in 1956.

**Douglas A. Ozey** was named field representative for the Oil Well Supply division at Dawson Creek, B. C. Ozey was employed by "Oilwell" in 1955 at Edmonton, Alta.

**CHICAGO BRIDGE & IRON CO.** has announced the transfer of three members of the sales department.

**Arthur R. Simpson,** a member of the general sales staff since 1945, has been assigned to the Chicago sales office. Simpson joined CB&I in 1937 after obtaining an M.S. degree in engineering from Purdue University.

**James R. Mansell** has been transferred to the Houston sales office from the company's Birmingham office. A 1951 engineering graduate of Mississippi State College, Mansell joined CB&I in 1955.

**George M. Rowley,** who has been with CB&I since 1955, has moved from the Hillside, N. J., erection district to the Boston sales office. Rowley holds B.S. degrees in physics and civil engineering from Monmouth College and Case Institute of Technology, respectively.

**HOOKER ELECTROCHEMICAL CO.** and **FOOTE MINERAL CO.** have formed a new corporation to be known as HEF, Inc. The new firm will specialize in the manufacture of components of solid fuels for rockets and guided missiles, specifically ammonium perchlorate and other perchlorates.

The corporate name of the jointly held company (HEF, Inc.) combines the initials of the two parent companies, and also signifies high energy fuels. The company has been incorporated in Delaware. While the new company expects to operate propellant production facilities, the location of such facilities will be announced later.

**ROCKWELL MANUFACTURING CO.** of Canada, Ltd., has purchased a new 50,000-square-foot plant at Guelph, Ontario, recently vacated by Hammond Manufacturing Co. of that city, **W. F. Rockwell Jr.,** president, has announced.

Purchase of the modern one-and-a-half-story brick and tile factory will enable Rockwell of Canada to meet demand throughout the Dominion for the wide variety of products manufactured in its existing 92,000-square-foot plant at Guelph.

Rockwell of Canada is a subsidiary of Rockwell Manufacturing Co., Pittsburgh, Pa.

**NOOTER CORP.** has elected two new vice presidents and two other individuals were named secretary and treasurer for the company, it was announced today by Robert J. Ryan, president.

Elected to the vice presidencies were **John Miller** and **William F. Hommert.** Miller formerly was assistant superintendent of the company. Hommert was a con-

WHEN SPECS CALL FOR...

# STEEL PLATE

*custom fabricated on the West Coast*

Save on transportation costs, manufacturing time and put yourself in a more competitive position by contacting an experienced "on the spot" source when planning the procurement of process and plant equipment for the West Coast. Send prints for prompt quotation on your next job.

*Request Brochure No. K-57*

PS F SINCE 1900

PUGET SOUND FABRICATORS, INC.

*Craftsmen in Metals*

3670 E. Marginal Way • Seattle 4, Wash.

*Craftsmen in steel plate and alloys up to 1"*



**Your**

**STRUCTURAL STEEL and STEEL PLATE FABRICATION**

# ON TIME!

We pride ourselves for "on time" delivery. Thoroughly experienced staff of designers, engineers, and fabricators, to furnish the steel you want, when you want it. AISC members. ASME pressure vessels, tanks, heat exchangers, as well as structural steel. Location served by SP and MP railroads, and our dock is on the Intracoastal Waterway. Write, wire or phone for FACT FILE on our complete facilities.

## ST. MARY IRON WORKS, INC.

Steel Fabricators for over Half a Century

FRANKLIN, LOUISIANA PHONE 820



**For Expanding Heat Exchanger Tubes**

# NEW WILSON Torq-Air-Matic

**First and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel**

Only the Wilson Torq-Air-Matic offers all these features: air driven, automatic trip-off, completely integrated, non-electrical, non-frictional, calibrated in ft lbs torque, lightweight, simply adjusted.

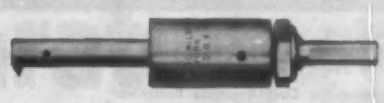
**Send for your copy of Wilson Bulletin 55.**

## Wilson Heavy-Duty Air Driven Cleaners

offer quick way to clean fouled heat exchanger tubes

## Wilson Tube Cutter

easy to use, does fast job, a fine, reasonably priced tool



**Representatives in principal cities**

**Thomas C. Wilson, Inc. • 21-11 44th Ave., Long Island City 1, N. Y.**

**Cable address: "Tubeclean", New York**

# WILSON

TW-860

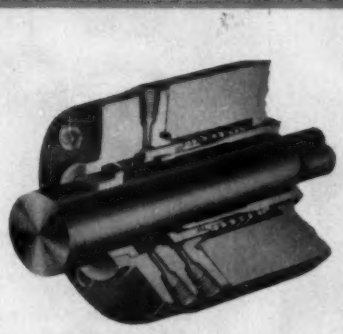
**TUBE CLEANERS • TUBE EXPANDERS**




**For more data on advertised products, use Readers' Service Cards, last page.**

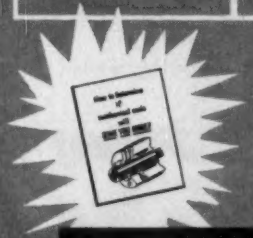
# How to determine if mechanical seals will SAVE YOU MONEY

Mechanical seals can play a vital, *often unsuspected* role in the economics of your plant operation.



**FOR EXAMPLE—**

| | |
|---|---|
| **PRODUCT LOSS** | Eliminating gland leakage prevents loss of valuable products . . . which could be substantial over a period of time. **How much would you save?** |
| **TIME** | Maintenance personnel time is minimized . . . and labor costs required to clean areas around leaking glands are eliminated. **How much would you save?** |
| **INVESTMENT** | You protect your overall investment by doing away with the prime trouble spots in handling dangerous, noxious, corrosive products. **How much would you save?** |



**FIND OUT HOW MUCH YOU CAN SAVE!**

Send for your free do-it-yourself Cost Analysis Bulletins. See for yourself exactly how you can reduce Product Loss—Save Time—Protect Investment.

**SEALOL**

**SEALOL CORP, 174 Post Road, Providence 5, R. I.**

Please send me Cost Analysis Bulletins.

Name..... Title.....

Company.....

Street.....

City..... State.....


## Suppliers . . .

struction sales engineer. Both will continue to fulfill those duties.

**Elmer W. Smitt,** formerly assistant secretary of the company, was elevated by the board to the office of secretary. **Herbert H. Koch,** whom Smitt succeeded as secretary, was elected Nooter treasurer.

**Simon C. Tracy,** veteran of 40 years with Nooter, was serving as vice president and treasurer of the company prior to the board's action. He will continue to fulfill his vice presidential duties.

**SCHUTTE AND KOERTING CO.,** manufacturing engineers, have announced the appointment of the William Thorrat Co. as their representative in northern Ohio.

**DEWRANCE & CO., LTD.,** announced that their subsidiary company, Jones, Tate & Co., Ltd., Victory works, Brasford, England, is now to operate as a division of the parent company to be known as the Jones-Tate division. C. E. Jones has retired and P. F. Gifford has been appointed divisional manager.

A. C. Jones, who has a degree in mechanical engineering, will be sales manager and operate from the London office, 165, Great Dover St., S.E.I. Correspondence other than sales will continue to be addressed to Victory Works, Brasford.

**ETHYL CORP.** has appointed Victor T. Mavity, Jr., a technical analyst-writer in the Information Services group, Detroit laboratories.

Prior to joining Ethyl, he was associated with Ashland Oil and Refining Co., Lago Oil and Transport Co., and Esso Standard Oil Co. He holds a B.S. degree in chemical engineering from Purdue University.

**HAMER VALVES, INC.,** has appointed the **William C. Turnbull Co.** to represent Hamer products in the greater Toledo, Ohio, area. The announcement was made by **Cleo Williamson,** general sales manager of Hamer Valves, Inc. The Turnbull Co. is headed by **William C. Turnbull.**

**HERCULES MOTORS CORP.** has moved its Houston factory branch to larger, modern quarters at 5031 Gulf Freeway. The expansion is part of the company's program of increasing service to users of Hercules engines in the petroleum, construction, agricultural, industrial and marine industries.

The Houston branch is under the supervision of **James A. Embry,** regional manager and **David A. Otto,** branch manager.

**A. W. CASH CO.** Decatur, Ill., has moved its offices to a three-story building in downtown Decatur. Former offices, in the Cash Standard plant at 18th and El Dorado Streets, have been converted to additional manufacturing area to meet the demands of expansion.

**UNITED STATES STEEL CORP.** has appointed **John C. Cushing** assistant vice president—commercial of its Supply division it was announced by **Keith P. Rindfleisch,** vice president—commercial.

A native of Chicago, Cushing entered Princeton University, where he graduated in 1939 with a B.A. degree. He began his career with the U. S. Steel Supply division in 1940 as a personnel interviewer in the industrial relations department.

He was made assistant manager of in-

*Posey-fabricated Propane Storage Tank . . . 64' long, 9' diameter. Shell 1" thick, heads ½" thick. Capacity 30,000 gallons liquid, working pressure 250 pounds per square inch.*

# POSEY Pressure Vessels

Let Posey Iron quote on your next pressure vessel job. Since 1910, Posey has been producing welded steel structures to meet a wide variety of industrial needs. Today Posey has the experience, facilities and manpower to fabricate vessels of any size, type or metal. Write for information about Posey installations in your industry. Your specifications and delivery requirements will be rigidly observed.

## POSEY IRON WORKS, INC.

*Steel Plate Division*

LANCASTER, PENNSYLVANIA

*New York Office: Graybar Building*

TANKS • STACKS • DIGESTERS • PIPE AND PILING

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# TEST METERS IN STAINLESS STEEL

Specially made for the measurement of small volumes of gases and with special applications in the Petroleum Industry. Robust and easily cleaned.

*Type E.40 Wet Meter, 1/10th cu. ft. per rev., 40 cu. ft. per hour, OR alternatively 2½ litres per rev., 1000 litres per hour. Stainless Steel case and drum.*

PARKINSON COWAN
INDUSTRIAL PRODUCTS

**PARKINSON COWAN INDUSTRIAL PRODUCTS**
Cottage Lane, City Road, London E.C.1. Tel. Clerkenwell 1766/7

---

# Aluminum Grating

**for ramps, walkways, pit covers, floorings, etc.**

Patented Upset design provides sure-footed, non-skid, non-directional safety—even in the presence of wet, greasy or other hazardous conditions. Non-magnetic, non-sparking and maintenance-free! Washington Aluminum will fabricate any shape, width or length grating to answer your most exacting requirements. Free booklet on request.

low as **$2.50** per sq. ft.

**WASHINGTON ALUMINUM COMPANY, INC.**
Dept. 54 Baltimore 29, Md. Phone Circle 2-1000

There's **extra** metal for **extra** strength in

# W-S 150 lb. STAINLESS STEEL FITTINGS

Exceptional strength and perfect alignment are features you can rely on in W-S 150 lb. Stainless Steel Fittings. Because they resist corrosion, stand up to extreme heat and cold, they're ideal fittings to safeguard the processes of petroleum, chemical, food and other process industries.

Specify W-S screw-end and socket welding fittings. Available in sizes ⅛" to 4"...in every type you may need. Materials: Stainless Steel types 304 and 316. ASTM-A-182, Grade F-304, F-316 for forged fittings. ASTM-A-296, Grade CF-8, CF-8M for precision cast fittings.

Forge and Fittings Division manufactures a full line of high quality fittings, unions and couplets...in carbon, stainless and alloy steels. For information about them and for your commercial forging and die casting requirements, write to Forge and Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, N. J.

**H. K. PORTER COMPANY, INC.**

FORGE AND FITTINGS DIVISION

W-S Fittings Works, Roselle, N.J. • Cleveland Forge Works, Cleveland 4, Ohio
Stainless Steel Works, Duncannon, Pa. • Cleveland Die Cast Works, Cleveland 4, Ohio

## Suppliers . . .

dustrial relations in 1942, and director of industrial relations in 1947.

**WALWORTH CO.** has announced the appointment of **Leo I. S. Conway** as assistant manager of the Metropolitan division. Conway joined Walworth in 1954 as a salesman in the Manhattan, N. Y. area. He previously served with the Lehigh Navigation Coal Co. as industrial salesman.

**WORTHINGTON CORP.** appointed the **McIntosh Equipment Corp.**, New York, as distributor of its standard pump and compressor line in New York.

Located at 15 Park Row in New York City, the McIntosh Equipment Corp. maintains a staff of sales engineers to offer advice and assistance.

**DAVISON CHEMICAL CO.**, division of W. R. Grace & Co., have announced the appointment of John F. Quinn and Albert J. Gnesin as district representatives.

Gnesin will be in charge of the Davison office in New York and Quinn in San Francisco.

Both have been with Davison in other assignments and have extensive background in the oil and chemical industries.

**BLAW-KNOX CO.** has announced the appointment of William D. Kohlins as general manager of its Buflovak Equipment division. He has been serving as division manager since 1956.

**E. W. Klapmeier**, general manager of the Dairy Equipment division of Blaw-Knox, who has been acting general manager of Buflovak for the past year, will devote full time to his regular assignment as general manager of the Dairy Equipment division, Mora, Minn.

Kohlins joined Blaw-Knox in 1946 as sales manager of the New York office, transferring to Buffalo in 1954 as director of engineering.

**CONSOLIDATED ELECTRODYNAMICS CORP.** has appointed Rear Adm. **Jackson S. Champlin**, USN (Ret.), as assistant to the director, DataTape division.

**Russell R. Palmer**, assistant to CEC's director of sales, was named to succeed Champlin as administrative manager of the division.

Champlin graduated from the U. S. Naval Academy in 1925 and completed the school's postgraduate course. He is a registered mechanical engineer in the District of Columbia.

Palmer joined CEC in 1951 after graduation from the University of California. He was an application engineer, supervisor of instrument order service, and manager of sales operations before his appointment as assistant to the director of sales in 1957.

**AMERICAN CYANAMID CO.** has elected as executive vice presidents **Kenneth H. Klipstein** and **George R. Martin.**

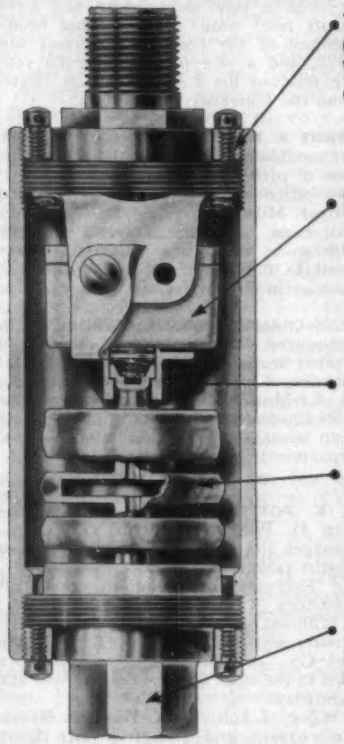
Klipstein, who joined Cyanamid in 1933, became a vice president and director in 1957. He has served as assistant general manager of the former Calco division and as general manager of the Research division.

During 1951 and 1952, Klipstein served as director of the Chemical division and as assistant administrator of the Chemical, Rubber and Forest Products bureaus of the National Production Authority. He received a B.A. degree in economics and an



For more data on advertised products, use Readers' Service Cards, last page.

# NEW PRESSURE SWITCH FOR HIGHLY CORROSIVE MEDIA


Threaded (adjustable) Construction Shown; Welded construction optional
Snap action Switch
Overtravel protection
Welded multiple diaphragm sensing element —not to be confused with an accordion bellows.
¼" internal pipe thread pressure connector is standard—Welding fitting optional.

***SAVE EXPENSE OF CHEMICAL PROTECTORS...OFTEN MORE THAN THE PRICE OF THE PRESSURE SWITCH***

This new tier-tube line of Meletron pressure switches is available in materials suitable for use with concentrated hydrogen peroxide, fuming nitric acid, liquid oxygen, proprietary amine fuels, fluorine, mixtures of fluorine and liquid oxygen and others.

Proof pressures range from 224 to 6000 P.S.I., pressure settings from 2 to 4800 P.S.I. Switches will operate in temperatures from −65° to +275° F. Standard pressure port fitting is ¼" internal pipe thread but may be substituted by special welding fitting. The housing serves as a pressure tight safety capsule in case of a break in the sensing element. Single pole double throw switching elements are rated to 10 amps., for AC and DC circuits. Free leads or Cannon plug are optional for electrical connection. As an added safeguard, the stainless steel models will withstand 2000° heat for five minutes.

Write for bulletins 1110 to 1170.

*PRESSURE SWITCH DIVISION*

**barksdale valves**

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

METEX

# MIST ELIMINATORS

(ENTRAINMENT SEPARATORS)

***Eliminate product loss, cut operating and maintenance ...at low first cost.***

Metex Mist Eliminators have been used successfully on many applications to knock back liquid entrainment. They are used in any vessel handling liquids and vapors when complete separation of the two phases is desired. Separation efficiency of 99%+ is maintained.

**Ask Metex for engineering recommendations. Write today for Bulletin ME-6 and a data sheet.**

METEX

8-107

**METAL TEXTILE CORP.**
ROSELLE, NEW JERSEY




For more data on advertised products, use Readers' Service Cards, last page.

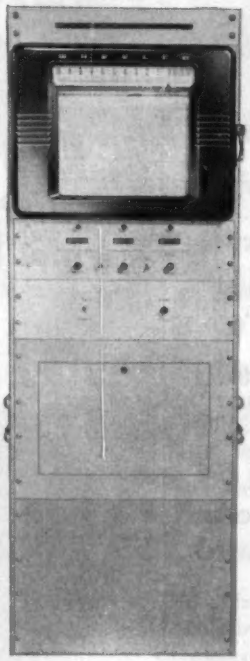
THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

**NEW**

**electronic integrator provides fast, selective counting rates**



New Wheelco electronic integrator and optional 5-digit component counters are unitized for convenient mounting

New from Wheelco — an electronic integrator with a selective counting rate of 2400, 1200, or 600 per minute at full scale. Developed for use with the Wheelco 8000 Series potentiometer strip chart recorder in chromotographic applications, the unit is equally effective on any industrial process where the measured variable must be integrated.

Now — control of laboratory or industrial processes that formerly required a high order of technical skill can be supervised by most competent laboratory technicians.

Recorders are available with cross-chart speeds of 2 seconds for scale spans of 1 to 10 millivolts and 1 second for spans of 10 millivolts and greater. Chart speeds are selected by change gears. Readout (optional) is provided by high-speed, 5-digit electromechanical counters for component and/or total count.

Behind this new development is a solid background of Wheelco development experience, manufacturing skill, and complete field engineering experience. These same qualities can be applied to your process control problem — contact your Wheelco field engineer for more details today.

BARBER-COLMAN COMPANY

Dept. D, 1597 Rock Street, Rockford, Illinois, U. S. A.

BARBER-COLMAN of CANADA, Ltd., Dept. D, Toronto and Montreal, Canada

Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Electrical Components • Small Motors • Overdoors and Operators Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

## Suppliers . . .

M.A. degree in chemistry from Princeton University.

Martin joined the company in 1927 to organize a legal department, and served as its head until 1951. He has been a member of the board of directors since 1928, and a vice president for 13 years. He received his B.A. and L.L.B. degrees from the University of Virginia.

**BRANT & NIELSEN CO., INC.,** contractors for sandblasting, painting and the application of protective coatings have opened a new office in Houston. James C. Jordan, former Milwaukee office staff estimator, has been appointed regional manager. Operations of the new office will be confined to the petroleum and chemical industries in the Gulf Coast area.

**ALLIS-CHALMERS MANUFACTURING CO.** has announced the appointment of E. F. Greiwe as manager of the Norwood Works centrifugal pump department. He succeeds M. L. Murdock, resigned. Greiwe joined Allis-Chalmers in 1936 and since 1955 had been manager of product sales, electrical department, Norwood Works.

**H. K. PORTER CO., INC.** has appointed **Dan D. Williams** assistant general sales manager and **Curt K. Wiley** to Pittsburgh district sales manager. Both men will serve the Refractories division in their new capacities.

Williams, a graduate of Princeton University, was formerly with E. J. Lavino and Co., and has sold basic refractories used in the steel, copper, cement, and glass industries.

Wiley, L.L.B. from Western Reserve University and B.A. from Mt. Union College, is a former president of the Gem Clay Forming Co.

**EHRHART & ASSOCIATES, INC.,** Los Angeles, has appointed **O. L. Lewis** chief engineer in charge of the E. & A. Engineering department in both the Los Angeles and San Francisco offices.

He came to E. & A. from C. F. Braun and Co. with about 20 years of engineering design and construction experience on process units for the oil and chemical industry.

**KEASBEY & MATTISON CO.** has announced several promotions. **Alen F. Nagle** will be manager of the company's Tubular products and sewer pipe sales department. He has a M.S. degree in bio-chemistry from Temple University and joined the company as a sales engineer.

**Frederick L. Bickel** has been promoted to section leader of the Insulation division. He joined K & M in 1957, having formerly been with the Campbell Soup Co.

**John B. Mills** has been appointed a field engineer, serving the Asbestos-Cement Pipe division. Prior to joining K & M in 1956, Mills was with Furnace Distributors, Inc.

**THE BABCOCK & WILCOX CO.** plans to expand its critical experiment laboratory at Lynchburg, Va., to include a 10-kilowatt "pool-type" test nuclear reactor. Scheduled for completion by July 1, the unit will be used primarily to conduct experiments involving nuclear fission at elevated temperatures, and also to test the products of B&W's nearby nuclear fuel element plant.



For more data on advertised products, use Readers' Service Cards, last page.

## Suppliers . . .

**DAVISON CHEMICAL CO.,** division of W. R. Grace & Co., has appointed **A. R. Worrall,** formerly general manager, industrial chemicals, as managing director for all services and staff organizations at Davison's Curtis Bay (Baltimore) works. He will also be responsible for the production of superphosphate and sulphuric acid.

**David P. Barrett** has been named general sales manager, industrial chemicals. He was formerly general manager, rare earths, and in his new post will continue to have responsibility for these products.

**HERCULES POWDER CO.** has formed a Chemical Propulsion division of its Explosives department with **Fred M. Hakenjos,** previously smokeless powder sales manager, named manager. This new division will be concerned with design, development, production, and sales of propulsion units for applications ranging from missiles to small power units. It will also encompass smokeless powder operations associated with propellant systems and sporting ammunition.

**DE LAVAL STEAM TURBINE CO.** has appointed **Dr. Karol Pilarczyk** director of research and development.

The staff of the research and development program has been increased for an expanded research program. **W. H. Wiebe** remains chief research and development engineer and **H. W. Ebeling** superintendent of the engineering laboratory.

**MASON-NEILAN,** division of Worthington Corp., has announced establishment of a new Instrument Sales division, with **James M. McAlear** as manager. Formerly manager of the Pulp and Paper Mill department, McAlear will supervise the sale of the complete Masoneilan Instrument line.

Also announced was promotion of **H. P. Fishwick** to be new head of the Pulp and Paper Mill department. He previously served as supervisor of sales and service engineering for paper machine drying and drainage systems.

**HILLS-McCANNA CO.** has appointed **S. A. Bezaury** exclusive representative in Mexico for the company's diaphragm valves, metering and proportioning pumps and force-feed lubricators.

C. A. Intertec will represent the firm in Caracas, Venezuela.

---

**HELP WANTED**

### REFINERY SUPERINTENDENT

**Middle East independent producer has opening for refinery superintendent with 10 to 15 years experience to supervise operation and maintenance new 30,000 BPD plant. Individual selected should be between 35-50 with ability coordinate American and foreign personnel. Resume and details should be addressed:**

**Box 287-R, PETROLEUM REFINER, Houston, Texas**

# Petroleum Refiner Classified Ads

**Petroleum Refiner New Classified Rates**

**RATES: Regular Classified** (undisplayed) **set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. Display Classified ads, set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * * *

**HELP WANTED**

### CHEMICAL and MECHANICAL ENGINEERS

A large and expanding international petroleum company has openings for several Chemical and Mechanical Engineers with outstanding ability. This is a challenging opportunity to share the responsibility of coordinating international refining operations. Excellent advancement opportunities for applicants with a minimum of 3 years petroleum or chemical industry experience. Immediate assignment to our Far East refineries or to our White Plains Headquarters with an eventual overseas assignment. Salary commensurate with experience, liberal annuity, insurance, hospitalization and savings plans. Will pay moving and transportation expense. Please send resume to:

DENNIS V. WARD
**STANDARD-VACUUM OIL COMPANY**
P. O. BOX 1000
WHITE PLAINS, N. Y.

### Sales Engineer Wanted

Well-established successful firm has opening in an expanding sales department for young man looking for an opportunity in sales work. Must be college graduate, not over 33, in good health and not afraid of work. Experience in refining-petrochemical industry preferred. Applicant will be trained at home office before moving into sales work on basis of salary plus commission incentive and traveling expenses. Our own sales personnel know of this advertisement. Your reply will be confidential and should be sufficiently complete to merit contacting you for an interview.
**Address Box 286-R PETROLEUM REFINER Houston, Texas.**

**FOR SALE**

**HORIZONTAL ALUMINUM TANK**
20,000 Gallon Capacity
9 foot diameter x 44 feet long
**Refinery Materials Company**
P. O. Box 14306 • JAckson 3-2189
Houston 21, Texas

■ 200 HP, G.E. Steam Turbine 3550 RPM inlet pressure 150 discharge 15. New and unused $750.00. Refinery Materials Company, Post Office Box 14306, Houston 21, Texas, JAckson 3-2189.

**POSITION WANTED**

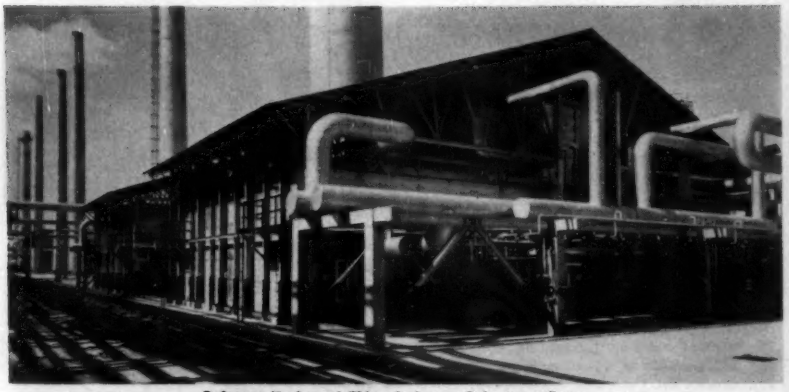
■ Heat exchanger rating Engineer employed in Germany desires similar position in Canada. EXPERIENCE: 3 years rating tubular exchangers, condensers, reboilers. 7 years draftsman and design-engineer with German affiliate U. S. engineering company since 1951. U. S. references available. For resume write to Box 288-R PETROLEUM REFINER, Houston, Texas.

**BUSINESS OPPORTUNITIES**

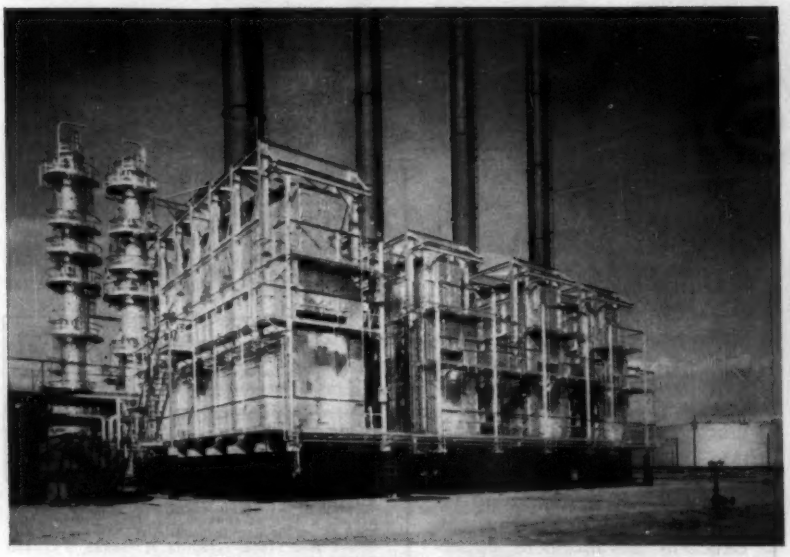
**NEW WATERLESS DECALS**

Permanent type tough "Vinyl" applied in seconds without water. Saves labor; no curing in storage. MADE TO YOUR SPECIFICATIONS...lettering, numbers, your trademark. Send now for FREE SAMPLES and estimate.
SCREEN PROCESS PRINTING CO., P.O. Box 948, Wichita 1, Kansas

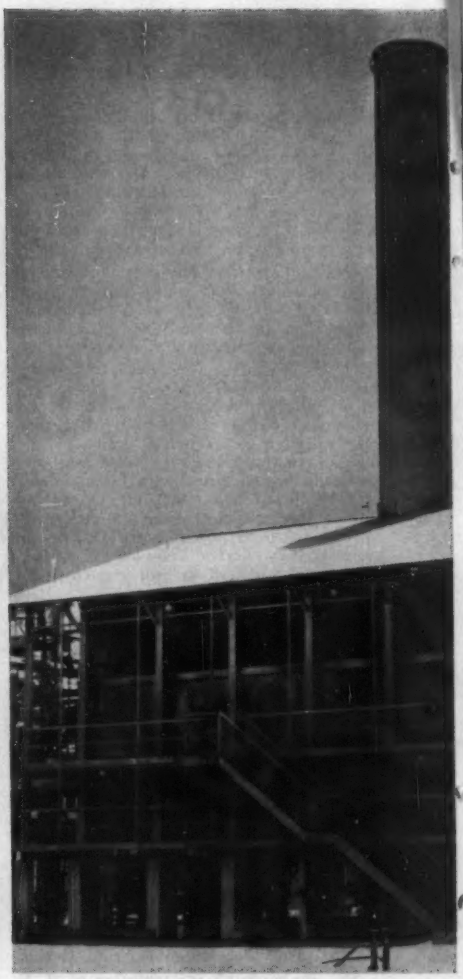
**Use Readers' Service Postcard for More Information on Advertised Products**



Reformer Heaters at Tidewater's new Delaware refinery.



Sovaformer Heaters at Magnolia Petroleum Company, Beaumont, Texas.



Thermofor Catalytic Reformer Heater at the Torrance, California refinery of the General Petroleum Corp.

# HIGHER EFFICIENCY, LUMMUS OIL HEATERS

**Lummus designs horizontal and vertical-tube oil heaters to any size, for any process—anywhere in the world.**

Major refiners confidently turn to Lummus on their important and difficult oil heater jobs.

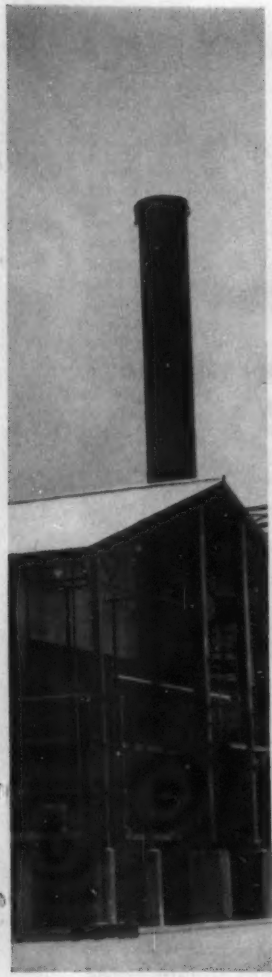
In the last 25 years, the combined capacity of all Lummus oil heaters built has exceeded that of any other company in the world. The reasons: greater durability, more efficient operation, an absolute minimum of days lost to downtime.

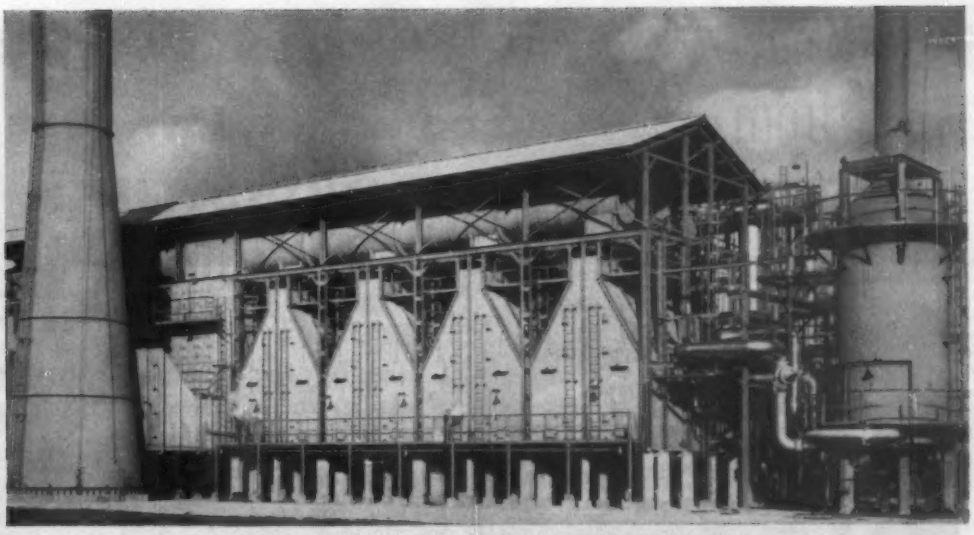
Major refiners maintain large engineering and economics staffs who can evaluate the performance of important heating equipment. They buy more Lummus oil heaters because they *know* through statistical comparison that Lummus gives them *more heater per dollar.*

In 1957 alone, Lummus received contracts to engineer more than 130 oil heaters, with a combined absorbed-capacity of over 7,000,000,000 Btu per hour — the largest number of units and highest overall capacity in Lummus' oil heater history!

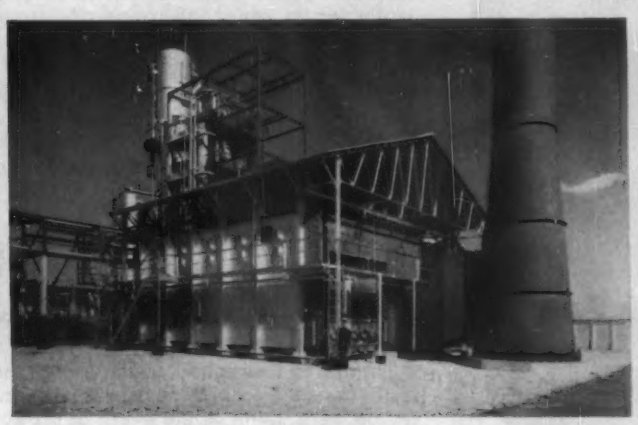
Lummus offers over a quarter of a century of oil heater experience for petroleum refineries, chemical and petrochemical plants. The highly trained engineering staff of the Oil Heater Division is ready in the Lummus New York office to give each job the full benefit of its accumulated know-how in this field.

Lummus oil heaters, of both special and standard design, range from 100,000 to 300,000,000 Btu per hour. As illustrated above, neither size, type nor location of the unit presents a problem to Lummus. Because Lummus offers *every* type of oil heater,

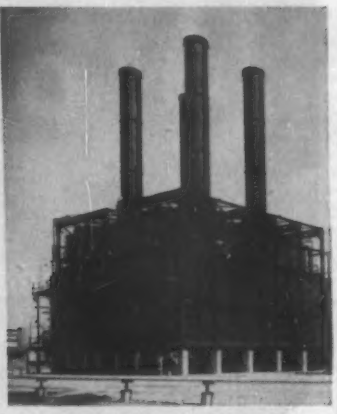




Ethylene Heaters for the National Petro-Chemicals Corporation at Tuscola, Illinois.



Topping and Vacuum Heater at the Suntide Refining Co., Corpus Christi, Texas.



Heater for 100,000 B/D atmospheric distillation unit for Gulf Oil Corp. at Port Arthur, Texas.

# MINIMUM DOWNTIME MAKE PREFERRED AMONG MAJOR REFINERS

you can be sure that we will recommend the *right* unit for your needs. Complete Lummus facilities are available world-wide through any of the five international Lummus companies. Equipment is designed in New York, procurement is made through the nearest Lummus international office, and the cost of the job is payable in the currency of the country in which the procurement is handled!

Consult with Lummus on your next oil heater — large or small.

LUMMUS

THE LUMMUS COMPANY, OIL HEATER DIVISION
385 MADISON AVENUE, NEW YORK 17, N.Y.

WASHINGTON, D.C. • CHICAGO • HOUSTON • MONTREAL • CARACAS • MARACAIBO • LONDON • PARIS • THE HAGUE



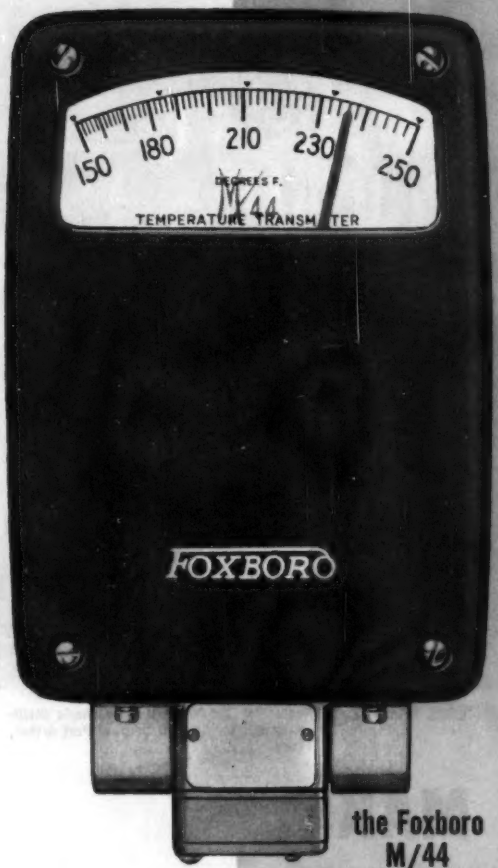
For more data on advertised products, use Readers' Service Cards, last page.

new from Foxboro!

## a compact, low-cost INDICATING TEMPERATURE TRANSMITTER

**engineered for fast, sensitive response under roughest field conditions.**

– uses any filled thermal system




the Foxboro M/44 Indicating Temperature Transmitter

Here's a brand new instrument engineered specifically for its job of indicating and transmitting temperature.

The M/44 Indicating Temperature Transmitter offers the inherent simplicity of a motion balance instrument. Compact and lightweight (10 lbs.) its indicating scale and fluorescent red pointer are visible up to 20 feet away. The output pressure of the M/44 is transmitted to any remote 3-15 psi recorder, controller, or indicator.

The M/44 is made with standard performance-proved Foxboro components, simply and conveniently arranged in a weather proof steel case. Changing range or type of thermal system can easily be done in your own plant.

Thanks to its rugged construction, the new M/44 is unaffected by vibration, sudden shock, or corrosive atmosphere. Even in the event of air supply failure, this instrument continues to indicate process temperature.

Ask your Foxboro Field Engineer about this new instrument. Or write for Bulletin 456-20A, The Foxboro Company, 744 Neponset Ave., Foxboro, Mass.

**Choice of Thermal Systems**

Foxboro M/44 Transmitters are available with any filled thermal system. These classes are suggested for particular range characteristics:

**Class II Vapor Pressure (100° to 600° F)**

Lowest cost, fastest response, highest sensitivity. Recommended for all installations within this range except when the measured temperature crosses ambient temperature.

**Class IA & IB Liquid Expansion (−250° to +600° F)**

Good response, good sensitivity, uniform scale. Uses smallest bulb of any filled thermal system.

**Class III Gas Pressure (−450° to +1000° F)**

Applicable to ranges beyond the limits of other filled systems. Uniform scale. Bulb has long sensitive section: permits useful averaging measurements.

green area is actual size silhouette of the new M/44

FOXBORO
REG. U.S. PAT. OFF.

TEMPERATURE MEASUREMENT AND CONTROL

# Reviewing New Books . . .

## 'Safety Rules and Talks'

The National Safety Council has two new publications available for industry—one for employes, the other for foremen. The publications, "Rules for Safety" and Book 8 in a series of "Five Minute Safety Talks for Foremen," are designed to promote safety in industry.

"Rules for Safety" contains 40 pages covering accident prevention do's and don'ts, how's and why's. The booklet gives safety rules for using power tools, stacking material and lifting and carrying.

"Five Minute Safety Talks for Foremen" lists 52 talks in Book 8, providing full and balanced coverage of the major types of occupational accidents. They range from "Why We Have a Safety Program" to "Bumping into People and Things."

(National Safety Council, 425 N. Michigan Ave., Chicago 11, "Rules for Safety" (minimum order of ten) 10 to 99, $.25; 100 to 999, $.18; 1,000 to 4,999, $.155; 5,000 to 9,999, $.145. "Safety Talks," 1 to 9, $1.95; 10 to 99, $1.75; 100 to 999, $1.65; 1,000 to 4,999, $1.60).

## 'Process Plant Practices'

This how-to-do-it manual of process plant problems and how they are solved in actual practice has just been published by McGraw-Hill. Practical methods and devices for dealing with a large variety of day-to-day problems in managing, scheduling, operating, maintaining, and repairing are described and illustrated. Cutting across the process industries, it deals with problems and equipment that are common to each. This book is designed for the supervisor as well as "the man who gets his hands dirty." Wherever possible there is such working data as dimensions, operating conditions, materials of construction, tools to use and how to use them, and other realistic information.

(McGraw-Hill Book Co., Inc., 327 West 41st St., New York 36, 312 pages, $10.00).

## Management For Engineers

This book takes a practical look at the impact of costs, standards, materials, methods, taxes, insurance, power, equipment, labor, and ethics; and shows the relationship between them and engineering considerations. It also describes the fundamentals of business cost considerations and shows how cash and credit work in behalf of the business purpose.

The engineer engulfed in problems which have precise mathematical answers is frequently not conversant with the economic, social, psychological, and political complexities of management. But these subjective concerns greatly affect and often completely dominate the decisions of business management, and are therefore given wide attention in this new book.

The author points out that such decisions must be based upon subjective as well as objective factors. This book will acquaint the reader with the workings of a business firm both as an economic institution and as a coordinate organization made up of individual participants.

(McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y., 453 pages, $6.75.)

## Statistics Manual

This manual was prepared for use by engineers and scientists in improving the efficiency of experiments by statistical procedures. Especially useful are a chapter on definitions and distributions and an appendix of tables and charts. Among these is a table which enables confidence limits for a standard deviation to be obtained immediately and charts which facilitate determination of sample sizes required for various experiments. Other sections cover such topics as test and confidence intervals for mean and standard deviations, tests of distributions as a whole, and allied problems; planning of experiments and analysis of variance; fitting a function of one or more variables; quality control charts; and acceptance sampling. Bibliographies are included.

(Order PB 131483 from OTS, U. S. Department of Commerce, Washington 25, D. C., 299 pages, $6.)

## How to Test Thermocouples

"Methods of Testing Thermocouples and Thermocouple Materials" was written by Wm. Roesner and S. T. Lonberger. It describes methods of testing and the precautions needed for reliable results.

The circular mainly considers calibration of platinum rhodium, copper-constantan, chromel-alumel, and iron-constantan thermocouples. Some guidance is provided in the selection of a test method best adapted to a given set of conditions. One section discusses calibration at freezing points, melting points, and boiling points, while another chapter covers calibration by comparison methods.

(National Bureau of Standards Circular 590, Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 21 pages, 20 cents.)

## Better Report Writing

The answer to problems of scientific expression for technical report writers is provided by this book. Presented are important details of effective scientific composition, style, division of reports, tables, illustrations, and use of words. Written as a quick reference instead of a classical exposition of technical English, the book simplifies the solution of writing problems for all technical authors. Three appendices condense information on abbreviations, symbols, and hyphenization.

(Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 231 pages, $4.75. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

## Finding Halogen in Gasoline

This book discusses a rapid method for the quantitative determination of ethylene chloride and bromide in gasolines. The method is based on the conversion of halogens from the organic to ionic forms through the action of sodium in liquid ammonia and then determining the ionic halogens by titrating with silver nitrate potentiometrically. With minor modifications, the method was applied successfully to the determination of fluorine, chlorine, bromine, and iodine in a number of organic compounds. Accuracy compared fa-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Three recently published items in PETROLEUM REFINER have enjoyed such a demand that they have been reprinted as separates and are available at $1.00 each. They are:

- **Fluid Catalyst Design Data,** by F. A. Zens: An up-to-date orientation and appraisal of recent developments in fundamental studies in fluidization.
- **Disaster Planning,** by Don E. Lambert: Details on how a refinery should prepare for disaster including planning, training, mutual aid, communications and public relations. This Report won an Editorial Award of Merit.
- **Perforated Trays,** by Huang and J. R. Hodson: The most reliable information available for design of perforated trays including handy work sheets to carry out your calculations.
- **Special Note**—We have also located a limited supply of section II of Wayne C. Edmister's **Applications of Thermodynamics to Hydrocarbon Processing** which was originally published in 13 parts in **Petroleum Refiner,** November 1948-December 1949. **Available at $1.00 a copy.**

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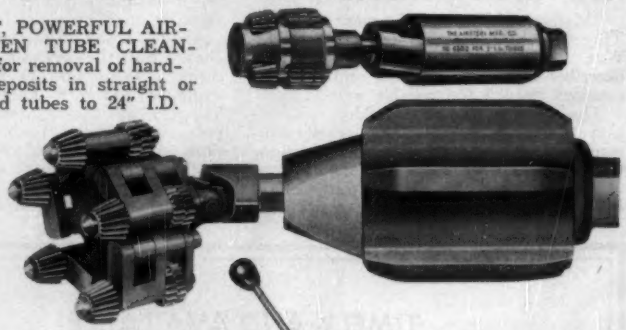
**Here are just a few of the many money-saving tools in the AIRETOOL line.**

FAST, POWERFUL AIR-DRIVEN TUBE CLEANERS for removal of hardest deposits in straight or curved tubes to 24" I.D.



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TUBE EXPANSION CONTROL . . . the answer to fast, easy, accurate tube rolling. Eliminates guesswork . . . over or under expansion. Quick set torque sensing cam stops expansion automatically to .001" accuracy. For tubes ¼" to 1-½" I.D. Send for Airetrol Bulletin #64.

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## New Books . . .

vorably with that of established procedures.

(Order PB 131242 from OTS, U. S. Department of Commerce, Washington 25, D. C., 25 pages, 75 cents.)

### Book of ASTM Standards

This 1957 supplement to the 1955 Book of ASTM Standards includes 76 standards covering crude petroleum; motor and aviation fuels; petroleum solvents and naphthas; kerosine and illuminating oils; lubricating, turbine, and electrical insulating oils; plant spray oils and petroleum sulfonates; lubricating greases; paraffin and hydrocarbon waxes; measuring and sampling; diesel fuels; coal; bituminous materials; and general testing methods.

Society for Testing Materials, 1916 Race St., Philadelphia 3, 340 pages, (American $4.00.)

### API Standard 620

Availability of an addendum to API Standard 620, Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks (First Edition), has been announced by the American Petroleum Institute. This is the first addendum, February, 1958. It covers errata, changes, and additions to Standard 620 (First Edition) published in February, 1956.

(American Petroleum Institute, Publications Department, 50 West 50th Street, New York 20, New York, 25c per copy.)

### A Study of the Thermal Decomposition of Methane

This book is based on an examination of literature concerning the nomogeneous pyrolysis of methene. A mechanism is proposed for the early stages in the decomposition of methene. This mechanism leads to a calculated over-all activation energy of 78 kcal in excellent agreement with the measured value of 79 kcal. The expression also agrees with the experimentally determined order of the reaction over the investigated pressure range. A discussion of the nitric oxide inhibition data is included.

(Order PB 121450 from OTS, U. S. Department of Commerce, Washington 25, D. C., 50 cents).

### 'Research Directory'

"Directory of Independent Commercial Laboratories Performing Research and Development, 1957" has been released by the National Science Foundation. A recent listing of this type of laboratory and its activities, the directory lists 565 laboratories, together with names of senior officers, numbers of research staff, and types of research activities.

(Superintendent of Documents, Government Printing Office, Washington 25, D. C., 40 cents).

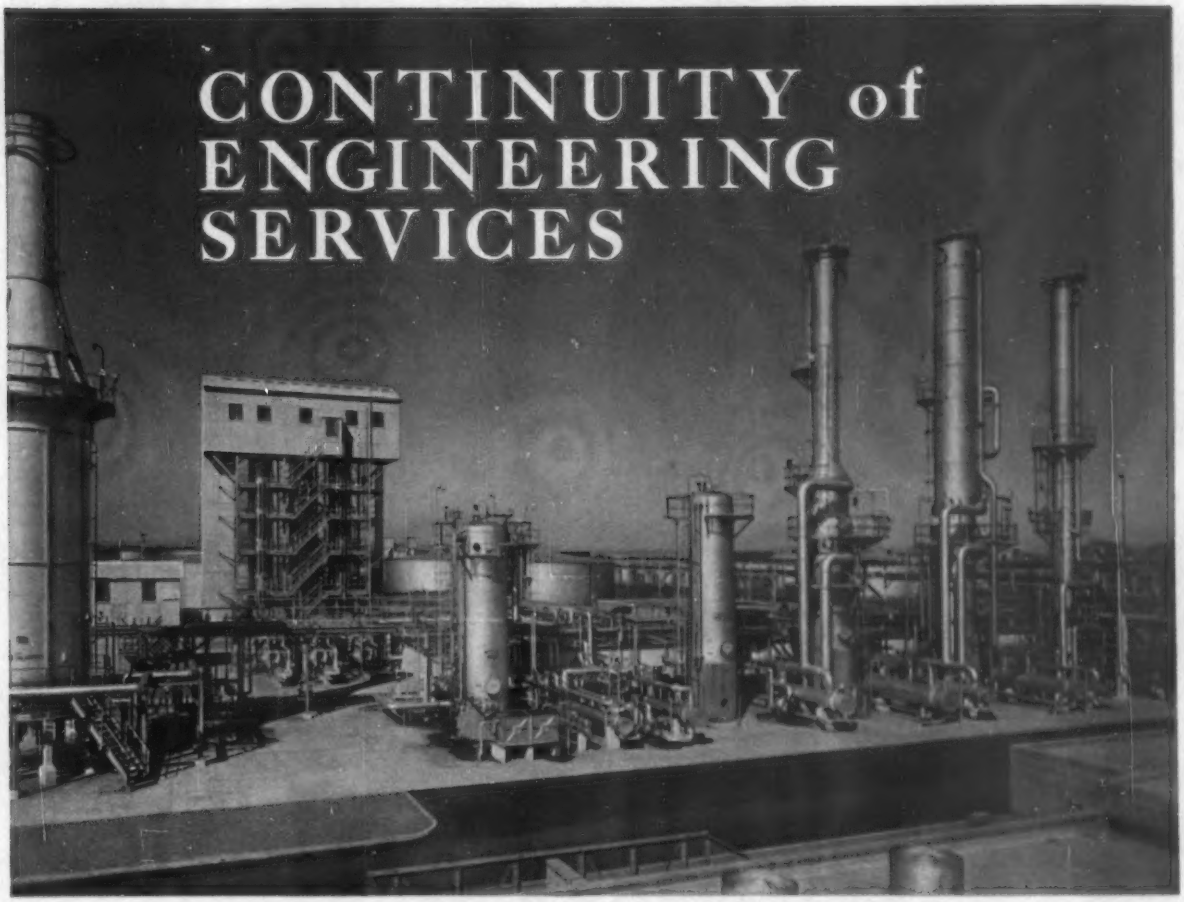
### Cooling Tower Performance

This manual brings together the data necessary for an estimate of size, fan horsepower, and pumping head of counterflow cooling towers. In addition, the data can be used to determine the performance of towers at other than design conditions.

(J. F. Pritchard & Co., 4625 Roanoke Parkway, Kansas City 12, Mo., 85 pages, $3.)



For more data on advertised products, use Readers' Service Cards, last page.




BRITISH HYDROCARBON CHEMICALS LIMITED recently placed in operation a Tetramer Plant employing the U.O.P. Process at their Grangemouth, Scotland chemical complex.

Stone & Webster Engineering Corporation, together with its affiliate E. B. Badger & Sons Limited engineered and constructed the new plant as well as the existing facilities for the production of Ethylene, Ethanol, Isopropanol and Detergent Alkylate. Work is now in progress on Polyethylene and Cumene-Phenol Plants.

The charge stock for the Tetramer Plant is propylene from the two existing Ethylene Plants. Part of the capacity of the new plant is used as a charge stock for the Detergent Alkylate Plant.

Stone & Webster Engineering Corporation's world-wide experience and client confidence, typified by its long association with British Hydrocarbon Chemicals Limited, is at your disposal.

*Write or call us for information as to how our experience may be of assistance to you.*

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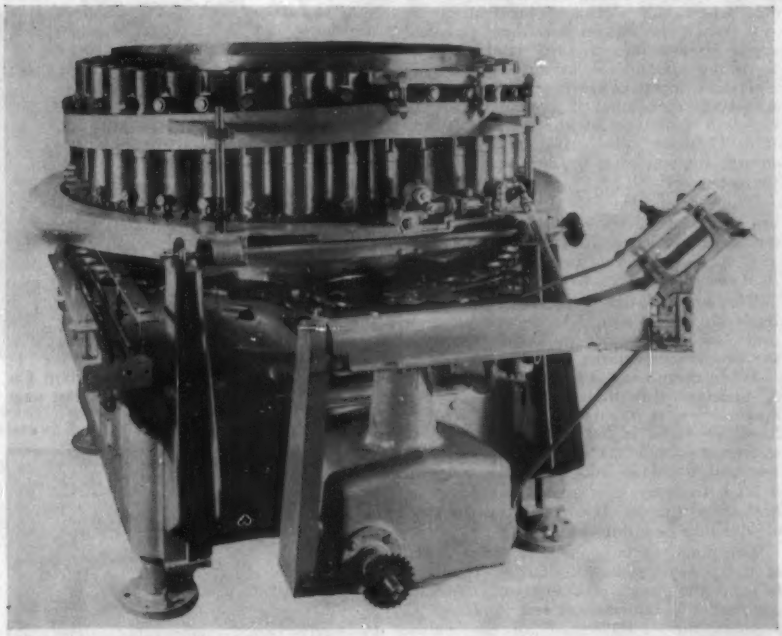
# What's New in Equipment . . .

## . . . and Manufacturers Literature



## Lube Filler Reduces Maintenance Time

A completely new designed, high speed-high capacity lube oil filler has been introduced to the petroleum industry. The 36 station filler was designed to meet the need for greater filling speed while maintaining requirements of clean, accurate fill.

The RPL-36 has a speed of 600-quart containers per minute with a filling accuracy of plus or minus 1/10 fluid ounce. Filling adjustments can be made from either of two conveniently located points while the machine is operating at full production speed. Centrifugal force spillage is overcome by means of a simple tilt adjustment of can support rails. High speed jamming is prevented by means of a uniform accelerating infeed screw for incoming empty containers. Straight line discharge with synchronized transfer of filled containers to closing machines further prevents spillage. A positive "no container, no fill" mechanism prevents product loss.

The new 36-station piston filler was conceived to reduce maintenance down time to an absolute minimum. There are only three primary wearing parts, namely the piston rollers, valve rollers and the valve trip cams, all of which are inexpensive and easily replaced. The Pfaudler Co.

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## Facilities for Custom Fabrication Described

A new data bulletin entitled, "Code Tanks & Pressure Vessels" is now available. Illustrated with examples of work being done and illustrations of plant facilities, the bulletin gives information on custom-fabricated equipment and facilities of direct application to the refining, natural gasoline and petrochemical industry. The bulletin is tab-indexed for easy file reference. Modern Welding Co.

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## Low Density Catalyst For Hydrogen Processing

Nicomo 1, a nickel-promoted cobalt-molybdenum catalyst on a special low density alumina base, developed specifically to meet the demands of the petroleum industry for a highly active, long-lived, economical and rugged product for catalytic hydrogen processing, is now available.

Usable in all industry processes where the requirement is for a cobalt-molybdenum type of hydrogen treating catalyst, Nicomo 1 is readily applicable to the pretreating of reforming charge stocks, the desulfurization of middle distillates, and the hydrogenation of cycle stocks.

Noting that catalytic hydrogen processing capacity in the U. S. is predicted to reach a total of 3 million bpd by 1965, from a current level of about 800,000 barrels, the company points out that this increased capacity will place a greater emphasis on the quality of the catalysts employed. Nicomo 1 was designed to meet this indicated need.

Development was preceded by an extensive research program designed to determine the optimum concentration of metals for maximum hydrogen treating activity. The resultant product is a low density catalyst, requiring up to 25 percent less catalyst to fill a reactor than with hitherto available products. In addition to its low density and porous structure, it is very strong and has a high resistance to attrition.

Nicomo 1, commercially produced as 3/16-inch extrusions by a unique process which insures the availability of the entire catalyst surface to the reactant streams, has been evaluated in a pilot plant and is now in commercial use in a typical hydrogen treating application. At equal process conditions an advantage of 6-9 percent in desulfurization is being consistently maintained over other types. Activity of the catalyst for hydrogenation, denitrification and metals removal is also excellent and indicates its general versatility in all applications. Davidson Chemical Co.

**Circle E3 green card, last page**

## Computer Reads and Writes 60,000 Digits Per Second

A 40-ton giant computer is fast enough to read the 627,000 names in the Detroit telephone book in 11 minutes, and versatile enough to play tick-tack-toe.

The Datamatic brain translates conventional records from paper or punched cards to a dot-dash electronic language on magnetic tape three inches wide. The system simultaneously "reads" and "writes" at the rate of 60,000 decimal digits per

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| | | |
|---|---|---|
| TIGHTNESS OF WEAVE | | |
| ACCURACY OF CRIMP | | |
| QUALITY OF METAL | | |
| UNIFORMITY OF WEAVE | | |
| WIRE THICKNESS | | |
| SPECIFIED SIZE | | |
| FLEXIBILITY | | |
| DURABILITY | | |

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Successful processing depends on the ability of the wire screens to resist corrosion, abrasion and blinding. The accuracy of openings and proper selection of metals, woven to exact job specifications are controlled by expert craftsmanship and engineering supervision.

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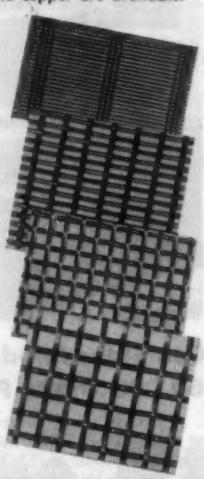

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## New Equipment . . .

second, while solving 1,000 multiplication problems or 4,000 additions or 5,000 comparisons.

A self-checking device assures absolute accuracy of the system's performance. According to engineers, only human error in feeding information to the machine could affect its accuracy.

The operator at the master-control console selects the particular program to be run. When the button is pushed, punched cards stream into a card reader which feeds the information as impulses into an electronic input converter. This converter translates the punched symbols into the dot-dash language of the magnetic tape unit. This unit can "write" or "read" this information on tape at the rate of 60,000 digits per second.

The records taken by the magnetic tape are now transmitted to the magnetic core memory, which can "memorize," compare and act on new information zipping into it at electronic speed by the tape units.

This memory makes the corrections and feeds the whole record to the output tape units, which re-record the whole file with the proper corrections.

When there is need to have any portions of these records that are stored on the magnetic tape translated into written form, the tape is fed through an output converter which takes the 60,000 digits-a-second dot-dash language and converts it back to letters and numbers through a high-speed printer. It can print at the rate of 900 lines per minute.

The magnetic core memory is the heart of the system. It has the uncanny ability to make the choices and to coordinate and compare the information fed it. It is, in a sense, the "intelligence" of the whole system. The Datamatic Division of Minneapolis-Honeywell Regulator Co.

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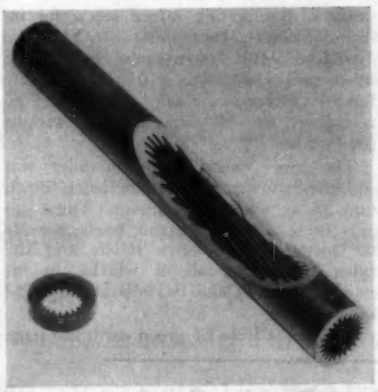

### Graphite Tubes Double Heat Exchanger Surface

A new impervious graphite tube with internal low fins that more than doubles the inner surface area of Karbate impervious graphite shell and tube heat exchangers has been developed. Twenty-three fins, each 3/16-inch high, increase the inner surface to 2.6 times that of a plain ⅞-inch I.D. tube. The fins twist helically through the length of the tube, providing turbulent flow at right angles to their longitudinal axis, thus accentuating the difference between streamline and turbulent flow, and increasing the heat transfer coefficient as fluid velocities increase.

The increased internal surface area of the new tube makes possible the design of heat exchangers with up to one-half the number of plain I.D. tubes in those corrosive services where the internal heat transfer coefficient is low and limiting. As a result, impervious graphite low-fin tube heat exchangers now provide excellent corrosion resistance at a cost approaching that of carbon steel, and less than that of austenitic and molybdenum stabilized austenitic stainless steel units.

The low-fin design, with its extra surface area, reduces the operating heat flux of a heat exchanger, and hence the temperature drops through the tube side fouling. This results in a longer operating cycle between cleanings, with a consequent reduction in maintenance costs.

The new low-fin tube has outer dimensions identical to ⅞-inch I.D., 1¼-inch O.D. plain impervious graphite tubes. This makes possible replacement of plain tubes in existing impervious graphite heat exchangers to provide greater capacity in the installation without changing flow plan, piping, or support structure. The new tube is available in 6-, 9-, 12-, 14-, and 16-foot lengths. National Carbon Co.

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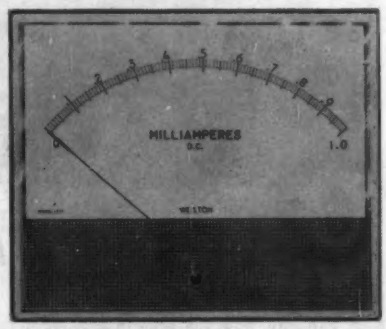


### Panel Instruments Have Extra Long Scale Lengths

A new series of large rectangular panel instruments offered in several accuracies and incorporating many new features such as excellent readability due to extra long scale length, excellent natural scale illumination and self shielding has just been announced.

Models 1371 and 1375 in this series utilize CORMAG mechanisms and can thus be mounted on magnetic or nonmagnetic panels without need for special adjustment. They are immune to the effect of stray fields, and are not affected by close proximity mounting. The all plastic transparent cover with clear top and sides insures excellent illumination of the long scale, thus eliminating the necessity for supplementary side or back lighting in most installations.

Where high sensitivity requirements are encountered, models 1373 and 1377 are available, with outside magnet construction. All other features of models 1371 and 1375 are found in this series, including clear plastic cover, extra long scale length and excellent natural scale illumination. Accuracy for these models is 2 percent for model 1373 and 1 percent for model 1377. For high sensitivity re-

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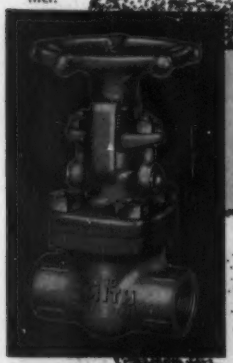
## GLOBE VALVE

The Smith family of Forged Steel Valves is growing! With our new G80R Globe Valve now in production, we can offer to the Process Piping, Chemical, Power and Shipbuilding Industries a line of small utility valves to meet their every requirement.

Like all SMITH Valves, our new Globe Valves have a *combination* of special features, which give them the ability to overcome problems of ever-increasing temperatures, pressures and corrosion — to give longer, trouble-free life in service at lowest maintenance cost.

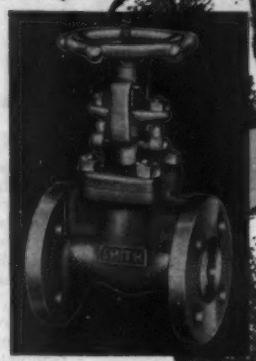
**It will pay you to send for our catalog giving full details on our new G80R Globe Valve and all other valves in the SMITH line!**

Smith "Figure 800" O S & Y Gate Valve Sizes: ¼" - 2" incl.

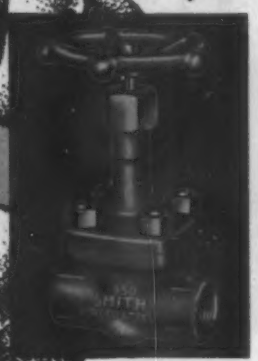


Smith "Figure 100" Needle Globe Valve Sizes: ⅛" - ½" incl.

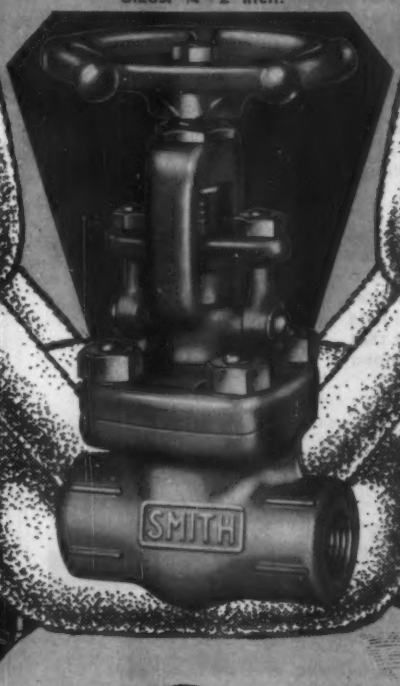
Smith "Figure 815" Flanged End Gate Valve Sizes: ½" - 2" incl.



Smith "Figure 850" Inside Screw Valve Sizes: ½" - 2" incl.



Smith "Figure G80R" Globe Valve Sizes: ¼ - 2 inch.



Smith FORGED STEEL Valves

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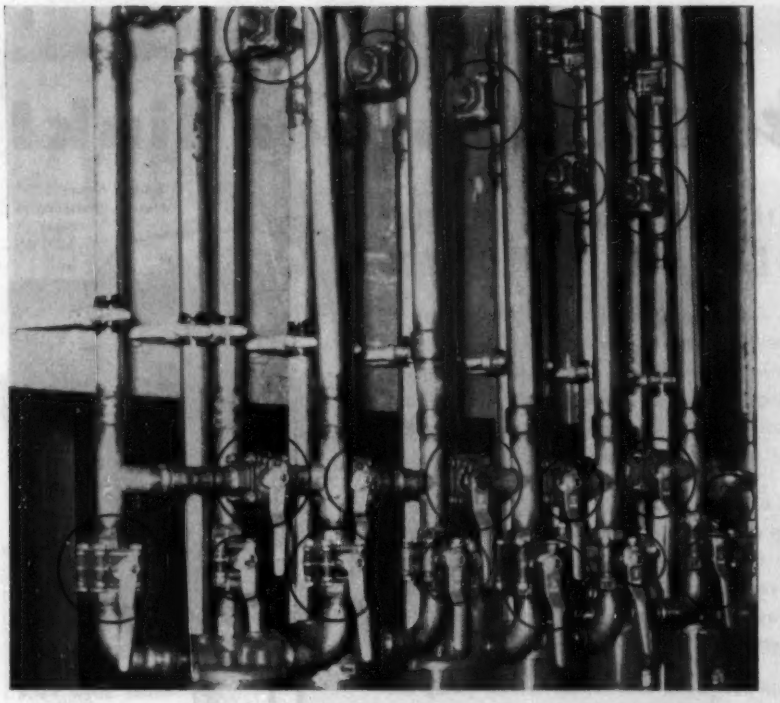
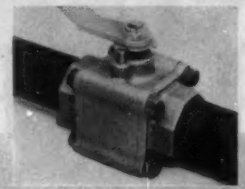


**Only the ECON-O-"MISER" Ball Valve was able to solve this problem for PathéColor, Inc.**

**THE PROBLEM:** To find a valve that would meet all of the following requirements:

*1. Quick visual indication of position and quarter turn operation. 2. Excellent flow characteristics and positive shut-off. 3. The advantages of flange construction without the bulk and weight of conventional flanged valves. 4. Easy & quick disassembling for low cost maintenance. 5. The most compact and economical installation of Type 316 stainless steel valves possible.*

**SOLUTION:** *Specifying* and *installing* Worcester's Econ-o-"miser" Ball Valve. In so doing PathéColor found a valve that provides a positive seal, a flanged construction much more compact than conventional valves that could be socket welded. In addition many unions and companion flanges were eliminated with the overall result that savings on this installation alone amounted to many hundreds of dollars.



Valves available, ¼"-2", in following standard materials*: Bronze, Aluminum Bronze, Aluminum, Carbon Steel and Types 303 and 316 Stainless Steel. Standard Seat and O-Ring materials*: Buna-N, Neoprene, and Teflon.

**Other materials available on request.*

*For further information and descriptive literature write to:*

**WORCESTER VALVE CO., INC.**

16 PARKER STREET • WORCESTER, MASS.

## New Equipment . . .

quirements these instruments also are furnished with conventional outside magnet construction. And where an accuracy of ½ of 1 percent is required, the model 1377 is available at slight extra cost. Weston Instruments Division of Daystrom, Inc.

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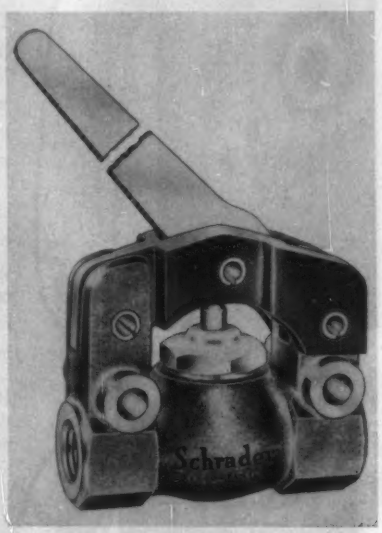


### Two and Three-Way Valves Feature In-Line Mounting

A new series of sturdy, compact two and three-way valves has been introduced. The poppet-type valves have specially designed brass bodies with ¼-inch inlet and outlet ports. Convenient in-line mounting holes and interchangeable actuating levers facilitate their applications to all types of air controls.

The valves have a 70 cfm air flow capacity and are identical in operation and actuation to the company's complete line of larger valves with larger air flow capacities. A. Schrader's Son, Division of Scovill Manufacturing Co.

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### Light Wall Stainless Steel Fittings Described

An eight-page booklet describing the uses and advantages of Quikupl stainless steel fittings has been released.

These stainless steel fittings have been designed to permit piping engineers to take full advantage of the new and more economical light wall tubing, although Quikupls are also furnished for both O.D. tube and IPS sizes. Elbows, tees, couplings, reducers and adapters from 1-inch to 4-inch sizes are available in stainless steel alloys 304 and 316.

The booklet cites specific examples with illustrations of how installation costs were cut drastically by using these fittings which eliminate the need for threading, welding or flaring. The booklet discusses their 100 percent salvageability and tells of their speed of set-up and space-saving features.

The booklet contains a table that is



For more data on advertised products, use Readers' Service Cards, last page.

designed as a guide to determine the relative effects of more than 330 chemical materials have upon the neoprene, butyl and Thiokol Quikupl seal rings. The classifications of good, fair and poor resistance are based on Vanton's research findings, on performance in actual service and on published material.

Simplified sectional drawings of the fittings and a table of stainless steel tube and pipe sizes suitable for use are included. Vanton Pump & Equipment Corp.

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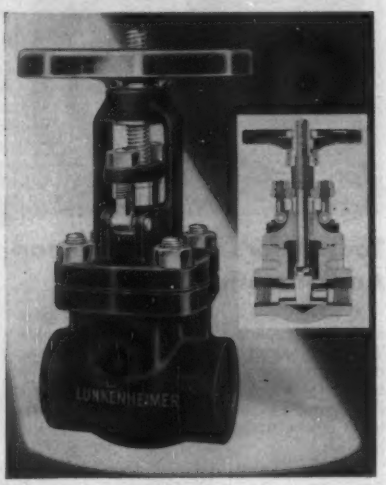


## Forged Steel Gate Valves For Use In Tight Places

A line of forged steel gate valves, completely new in design and compactly built for easy installation in the most cramped quarters, is now being introduced.

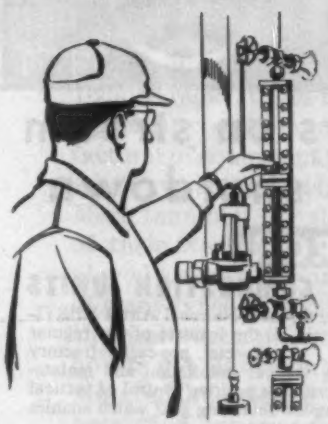
Featuring the preferred bolted bonnet design, with outside-screw rising stem, solid-wedge disc, and rolled-in seat rings, these gate valves are available with screwed or socket welding ends in sizes ½ inch through 2 inch. These valves are rated 800 pounds at 850 F., and 2,000 pounds at 100 F.

The solid-wedge disc is accurately machined and guided to a firm, tight seat without dragging across the seat rings. Both the disc and seat rings are hardened all the way through to eliminate chipping or cracking of seating faces. Discs are 13 chrome stainless steel, hardened to 500 brinell. Rolled-in 13 chrome stainless steel seat rings assure a tight seal without leakage.

A two-piece gland with ball and socket joint prevents binding due to uneven pull-up of eyebolts. The gland follower of stainless steel resists corrosion and prevents scoring of the stem. Deep stuffing boxes filled with quality packing assure long service life. Accurately machined back seats permit repacking under pressure when valve is wide open. Glands are held in place by hinged-to-bonnet eyebolts. When nuts are removed, eyebolts swing out of the way, permitting easy access to stuffing box.

The handwheels are keyed to the yoke bushing providing a strong torque-trans-


# It's easy to see why... Penberthy gages are preferred



● **PENBERTHY GAGES** on surge tank to gas treating plant of gas booster station. Natural Gas Pipeline Co., of America, Poberts County, Texas.

To be sure of clear, accurate liquid level readings... at temperatures from sub-zero to over 750° F. and to pressures exceeding 10,000 psi... simply specify Penberthy Gage Sets.

Used extensively for fluids ranging from water to highly corrosive and dangerous chemicals, Penberthy gages are available in a variety of materials including bronze, iron, carbon steel, stainless, monel, etc.... from stock or designed to specifications.

Exclusive construction features simplify maintenance, assure perfect alignment of frame with glass and gasket and permit servicing without removing assembly from vessel.

Request on your letterhead will bring you a copy of Catalog 36 detailing and illustrating complete line.

*Everywhere... you're seeing more* **PRODUCTS BY**

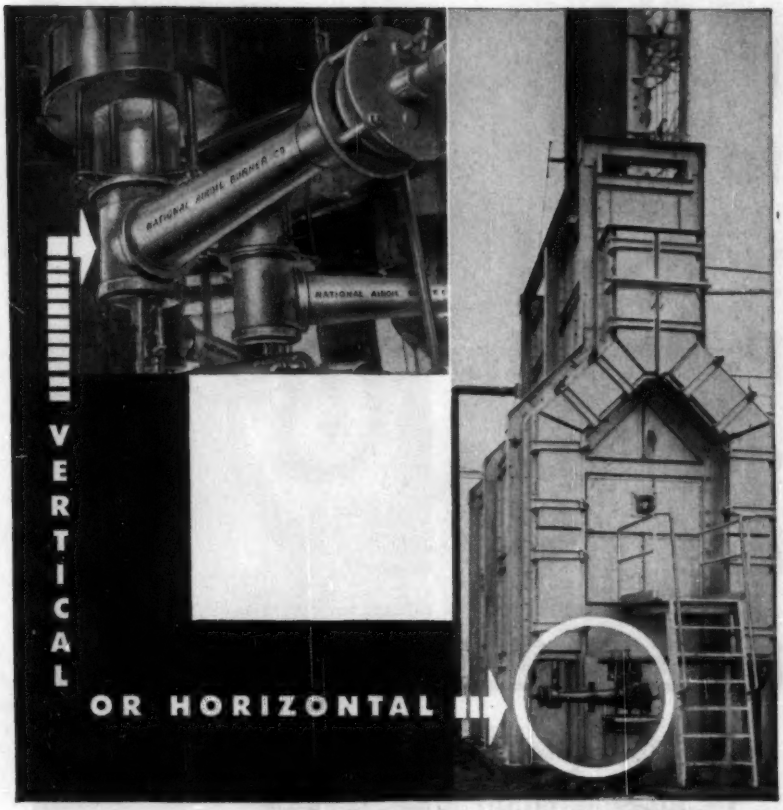
**PENBERTHY MANUFACTURING COMPANY**
*Division of Buffalo-Eclipse Corporation*
**1242 Holden Avenue • Detroit 2, Michigan**
**Dept. R**

PENBERTHY

- EJECTORS
- INJECTORS
- CYCLING JET PUMPS
- LIQUID LEVEL GAGES
- GAGE VALVES
- SUMP PUMPS




For more data on advertised products, use Readers' Service Cards, last page.




many more hours on stream without forced shutdown with NATIONAL AIROIL

OIL-GAS TANDEM COMBUSTION UNITS

Exclusively for vertical firing, the new National Airoil VERTICAL Tandem Block Units retain all the features of our regular horizontal Tandem Units . . . *plus:* special, pre-cast refractory shapes for easier, cost-saving vertical installation and maintenance; secondary air inlet louvres for positive control of vertical flame pattern; and, all steel duplex detaching gear which enables swift, simple vertical burner changeover.

VERTICAL and HORIZONTAL Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Units allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

The VERTICAL or HORIZONTAL Tandem Unit is always fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . has a high turndown ratio with a steady flame temperature using either fuel oil or gas. With the TANDEM UNIT'S clean flame, a cold furnace can be brought to full capacity in a short time.

"Many, many more hours on stream, without shutdown" . . . yes, YOU will realize higher profits from YOUR heaters when NATIONAL AIROIL VERTICAL or HORIZONTAL Tandem Units are specified. Our new Bulletin 498 is yours for the asking.

NATIONAL AIROIL BURNER CO., INC.

CHEMICAL-PETROLEUM DIVISION

*Main Office & Factory: 1254 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.*

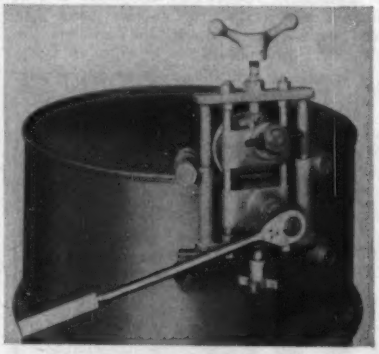
*Southwestern Division: 2512 South Boulevard, Houston 6, Texas*

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

## New Equipment . . .

mitting connection. All parts are easily dismantled and reassembled. Yoke bushings are 13 chrome stainless steel, with long-stem thread engagement, assuring good corrosion resistance and extended service life. The Lunkenheimer Co.

Circle E9 green card, last page



### Tool Shears Out Drum Head And Smooths Cut Edges

A completely new development in portable drum openers has just been revealed. The deheader quickly and easily shears down through the head against the inside body of either full or empty drums while smoothing cut edges of metal against the body of the drum, eliminating all handling hazards.

The tool will dehead drums ranging from 14 inches to 28½ inches in diameter, with chimes ranging from ¼ inch to 1½ inch in depth, and of 16-gage steel and thinner. It is sturdily constructed with hardened tool steel 4-inch shear and traveler. L. M. Gilbert Co.

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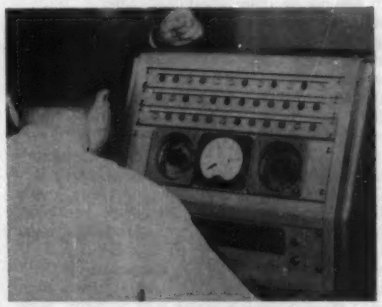

### Control Device Optimizes Yields In Your Processes

A new kind of experimenting control to optimize yields will be the basis for the next great advance in automation of the chemical and processing industries, predicts Dr. R. A. Ramey, manager of the Westinghouse Electric Corporation New Products Engineering department.

Called "Automex," a name derived from Automatic Experimenter, the new control device differs radically from conventional controllers which attempt to

maintain an operating quantity at a set point. Automex coordinates the set points of a number of controllers so as to optimize the yield of a process, just as an experienced human operator does.

For less competitive products, for which the demand is greater than the supply, the device may be used to maximize throughput rather than to minimize cost.

"The real advantage of Automex is that it can optimize processes in which the relation between input and output quantities is not exactly known," Dr. Ramey declared. "In fact, the characteristics of the whole process may be changing with time due to the influence of uncontrolled variables."

The principal requirement for the use of the device is the ability to measure the quantity to be optimized. Instrumentation for on-stream analysis is undergoing intensive development and infrared spectrophotometry, mass spectrometry, polarography and other similar methods are more frequently used. As a general principle, the better a process can be measured, the better it can be controlled. Westinghouse Electric Corp.

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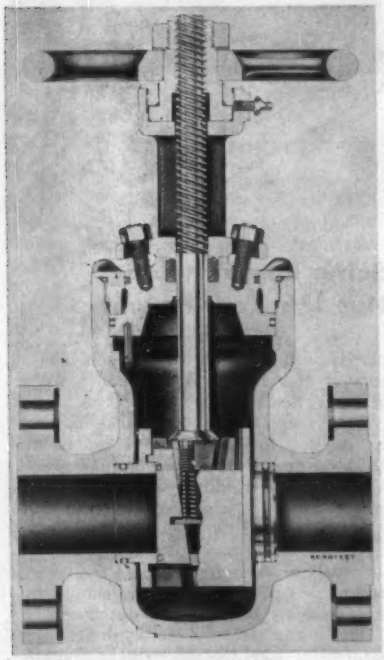


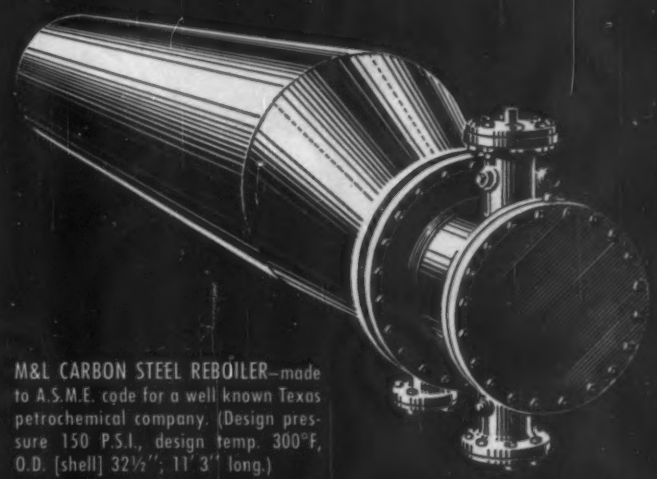
## Seat Wear Eliminated by Improved Valve Design

A non-lubricated, optional-flow, double block and bleed full opening valve, completely new in concept has been developed to handle gases, petroleum products, petrochemicals fluids, etc.

Features: a new principle of operation which eliminates galling or wear at the seating surfaces; insurance against product contamination through a vapor tight seal; time and labor saving design which permits servicing without having to remove the valve from the line; plus minimum maintenance.

Provision has also been made for the


MANNING & LEWIS



M&L CARBON STEEL REBOILER—made to A.S.M.E. code for a well known Texas petrochemical company. (Design pressure 150 P.S.I., design temp. 300°F, O.D. [shell] 32½"; 11' 3" long.)

Today's rapid strides in the technology of processing plant operation make it essential for a manufacturer of equipment to be "staffed up" with people who have had extensive training and experience. More than half our staff have spent a major part of their working life in this one field and have played a major role in the design and fabrication of many types of processing equipment. They know the limitations and workability of all metals and how to get maximum service from each. This accumulated knowledge of base materials and our extensive experience in design and fabrication means practical, trouble-free equipment at the lowest possible cost.

It is impossible, in a field requiring such wide diversification, to illustrate, or even list, all the products we have been called upon to supply. The reboiler above is simply one among thousands.

*Call on us the next time you need equipment. We are fully qualified to design and fabricate to all codes.*

M&L MANNING & LEWIS

ENGINEERING COMPANY

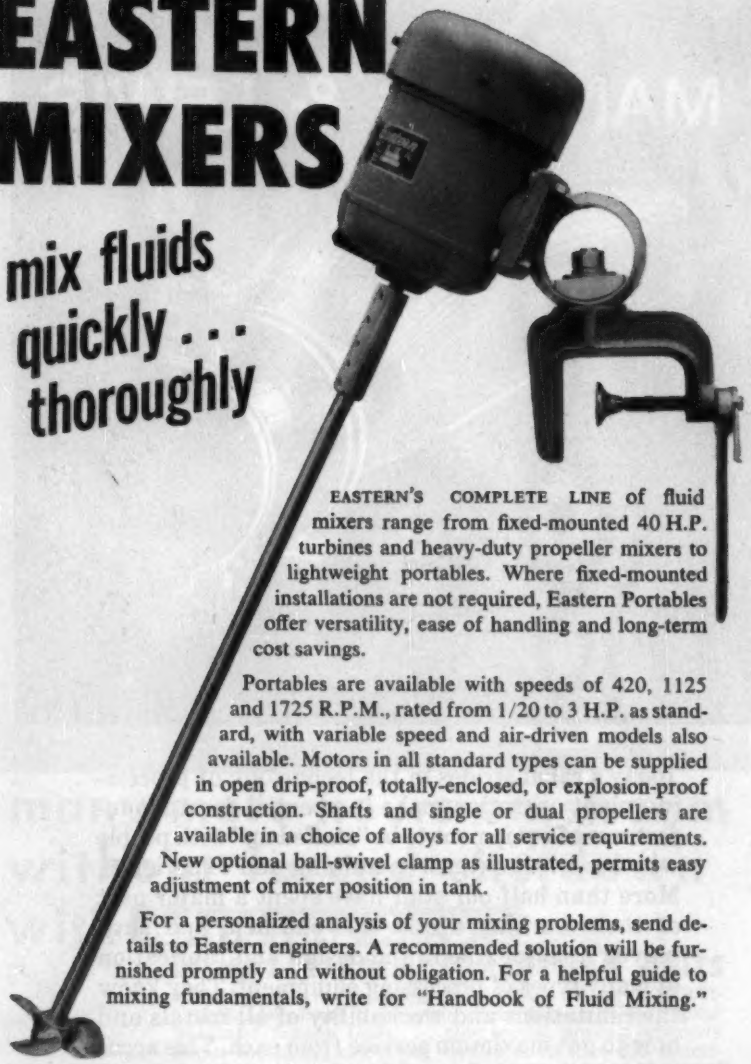
28-42 Ogden Street, Newark, New Jersey

Dept. C

DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT

# EASTERN MIXERS

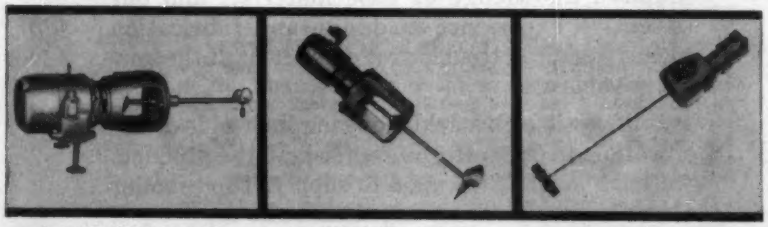
## mix fluids quickly . . . thoroughly



EASTERN'S COMPLETE LINE of fluid mixers range from fixed-mounted 40 H.P. turbines and heavy-duty propeller mixers to lightweight portables. Where fixed-mounted installations are not required, Eastern Portables offer versatility, ease of handling and long-term cost savings.

Portables are available with speeds of 420, 1125 and 1725 R.P.M., rated from 1/20 to 3 H.P. as standard, with variable speed and air-driven models also available. Motors in all standard types can be supplied in open drip-proof, totally-enclosed, or explosion-proof construction. Shafts and single or dual propellers are available in a choice of alloys for all service requirements. New optional ball-swivel clamp as illustrated, permits easy adjustment of mixer position in tank.

For a personalized analysis of your mixing problems, send details to Eastern engineers. A recommended solution will be furnished promptly and without obligation. For a helpful guide to mixing fundamentals, write for "Handbook of Fluid Mixing."



SIDE-ENTERING MIXERS
Handle the extra heavy-duty jobs in big tanks. Sizes ¼ to 30 H.P. Send for Bulletin 620.

TOP ENTERING MIXERS
Designed for heavy-duty applications requiring agitators from ¼ to 10 H.P. Send for Bulletin 620.

TURBINE MIXERS
Range of ¼ to 40 H.P. solve many special mixing problems. Send for Bulletin 1210.

NEW PORTABLE MIXER BULLETIN

*Eastern's improved line is included in the revised Bulletin No. 530.*

Eastern INDUSTRIES, INC.
Dept. A-2. Norwalk, Conn.

EASTERN INDUSTRIES MIXER DIVISION


## New Equipment . . .

installation of a bleed valve—a positive check on the efficiency of the seal. Sticking, friction, chatter, and wiping action across the sealing surfaces has been eliminated.

Driven either by handwheel, gear, or motor, the valve is operated by the raising or lowering of the threaded stem. In opening the valve, the counter-clockwise turning of the hand wheel first withdraws both upstream and downstream discs from contact with the seat rings in the body before raising them out of position, thereby eliminating drag during the opening operation.

In closing, the discs are held away from floating seat rings until the final point of closure is reached, at which time a wedge type spreader forces the discs against the seat rings. Teflon inserts in the discs form a vapor tight seal.

An effective new method of guiding the seat disc assembly, completely independent of the valve body, maintains clearance between discs and seat rings during operation. Kerotest Manufacturing Co.

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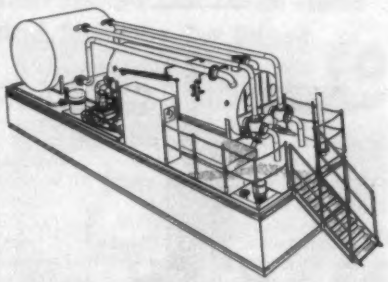

### Sulfur Recovery Unit Has 1½ Year Payout

A new sulfur recovery unit has been placed on the market which is designed to convert $H_2S$ (acid gas) to molten sulfur of the highest purity.

The complete, shop-assembled unit can be shipped to any desired location and quickly installed on a concrete pad simply by connecting it with a supply of electric power and the acid gas. No field construction crew is required.

The estimated plant payout period, even for small units, is from 1½ to 2½ years, depending upon local costs and conditions; larger units reportedly pay out faster.

The sulfur recovery unit is designed in accordance with the most recent developments in the industry and is licensed by Pan American Petroleum Corp. The entire unit can be installed at a minimum cost, the firm says. Tears Engineers.

**Circle E13 green card, last page**

### Bulletin Describes Tools For Digging & Demolition

A new bulletin entitled "Accessories for Demolition and Digging Tools" to serve as a comprehensive catalogue of the company's complete line of digging tools and accessories has just been published.

The new 24-page bulletin includes a

## New Equipment . . .

useful page on reforging, sharpening and the proper method of hardening these tools. This full-page guide can be removed from the pamphlet and tacked-up as a wall chart for quick reference in the reconditioning shop.

A special section of the bulletin tells about safety tools of forged beryllium copper to be used where sparks can't be tolerated.

In all, the bulletin describes 16 variations of the manufacturer's digging and demolition tools and 64 accessories. Ingersoll-Rand.

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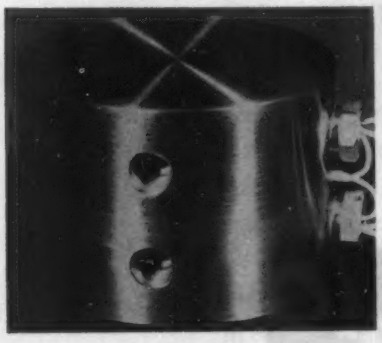


### Cell Can Be Added To Existing Chromatograph

The CDC-1 thermal conductivity cell, specifically designed for vapor phase chromatography, employs thermistors as sensory elements. Available in two sensitivity ranges, the cell can be incorporated into existing chromatographic apparatus or used as a component for new equipment. The unit operates to 240 C.

The cell features small internal volume, fast response and convenient mounting. Cell enclosure is stainless steel. With leak-free connections, the unit can be completely immersed in air, oil or water.

The 3,000 Series and 6,500 Series cells require 7.5 and 12 vdc respectively, at 3-22 ma.

A sample injection fitting, which can also be used for hypodermic removal of a small sample, is available as supplementary equipment. Largent Co.

**Circle E15 green card, last page**

### Plastic Flow Nozzle Meters Corrosive Fluids

An insert type Venturi flow nozzle, fabricated of fiberglas-reinforced polyester plastic, is now available for metering many of the corrosive fluids for which metal constructions are unsuitable . . . non-oxidizing acids, corrosive salts, and weak alkalies. This type construction is also satisfactory for some alcohols, formaldehyde, refinery crudes and gasoline, with modified designs available to handle slurries.

The model NZRP nozzle comes in line sizes ranging from 2 inches to 24 inches, and is suitable for pressures up to 150

Centrifugally Cast Pipe is STRONG Pipe.....

Planning to install high pressure lines in your plant? Will they carry hot corrosive liquids or gases?

You will find SAFETY in DURASPUN Centrifugally Cast Pipe. It's very strong, with strength approaching that of forged steel. It can be alloyed to give you maximum resistance to the heat and corrosion to be encountered.

.it's alloyed to resist corrosion and high temperature

DURASPUN Pipe comes in a wide range, as follows:

| Outside Diameter | Minimum Wall | Length |
|---|---|---|
| 2½" to 3" | 1/4" | 88" maximum |
| 3" to 6" Inclusive | 5/16" | 110" maximum |
| Over 6" to 12" Inclusive | 3/8" | 168" maximum, 24" minimum |
| Over 12" to 14" Inclusive | 7/16" | 168" maximum, 24" minimum |
| Over 14" to 20" Inclusive | 1/2" | 180" maximum, 48" minimum |
| Over 20" to 24" Inclusive | 1/2" | 88" maximum |
| Over 24" to 32" Inclusive | 5/8" | 80" maximum |

This is standard piping. Special cylindrical shapes in comparable high alloy steel can be cast centrifugally . . . retorts, furnaces, fractionaters and other such equipment come in this class.

Write us about your requirements. Our metallurgists backed by thirty-five years of experience will be glad to help select the best combination of alloying elements to take care of your operating conditions.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.




For more data on advertised products, use Readers' Service Cards, last page.

# NOW

*to serve modern industry's increased requirements...*

**Carrier**

*steps up the capacity range of world-famous Carrier*

# CENTRIFUGAL COMPRESSORS

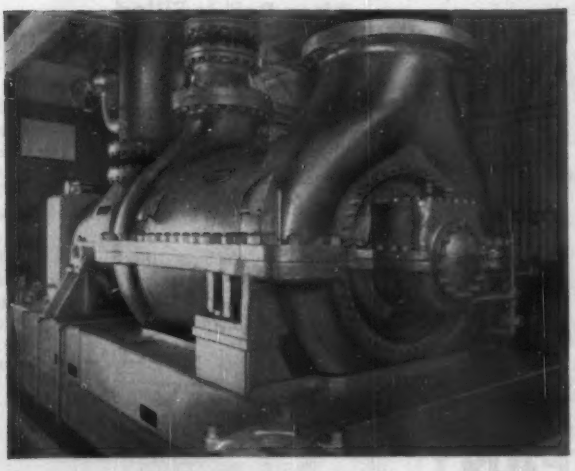
## to 150,000 cfm

For thirty-five years, Carrier Centrifugal Compressors have been serving leaders of industry in refineries and chemical plants throughout the world. In that time, they have earned an outstanding reputation for dependable, efficient performance. Now this same high standard of performance is available in an expanded Carrier line of multi-stage air and gas compressors with nine frame sizes from 1000 to 150,000 cfm. Each frame size is offered in 1 to 9 stages, depending on frame size, to meet your needs.

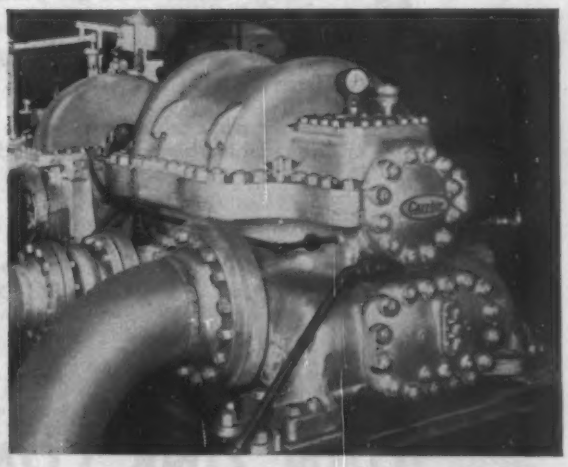
Many factors, of course, must be considered in selecting the right compressor for a job. The experience of the manufacturer is, of course, the most important. Carrier has built more multi-stage centrifugals than any other maker. Craftsmanship is important, too. Carrier has the most modern facilities for the production of centrifugal compressors. Finally, there is application skill. Carrier has handled more kinds of gases than any other manufacturer.

To make sure of getting the best compressor for your job, talk with your Carrier specialist. He will recommend the Centrifugal Compressor best suited to your needs. Call your nearest Carrier office today. Or write

## CARRIER CORPORATION • SYRACUSE • NEW YORK



**For volume flow up to 150,000 cfm,** Carrier now offers an expanded line of multi-stage Centrifugal Compressors for air and gas in nine frame sizes.



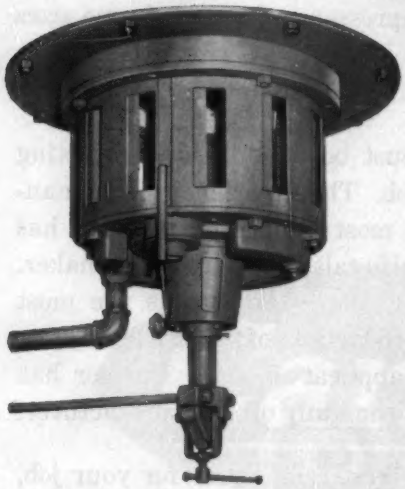
**For volume flow starting at 1000 cfm,** Carrier Centrifugal Compressors are the dependable, efficient answer. This unit is the smallest in the line.



For more data on advertised products, use Readers' Service Cards, last page.

# *the Best**

## VERTICAL COMBINATION GAS & OIL BURNER



## JOHN ZINK

series

## "DA"

* Oil spillage cannot cause gas burner plugging.

If the oil can be pumped, the "DA" can burn it.

No matter what calorific value gas is made available, this burner can handle it safely and quietly.

*For detailed information, write for Bulletin DA-357.*

WE MAKE HEAT ... AROUND THE WORLD

## JOHN ZINK COMPANY

4401 SOUTH PEORIA TULSA 5, OKLAHOMA


## New Equipment . . .

psig and temperatures up to 250 F. on most applications. It offers the high head recovery characteristics of the Venturi design. Features include an uncalibrated accuracy within ± 1 percent of the actual rate of flow (laboratory calibration can provide precise discharge coefficient and improve accuracy to ± ½ of 1 percent), and a wide pH range. Builders-Providence, Inc., division of B-I-F Industries, Inc.

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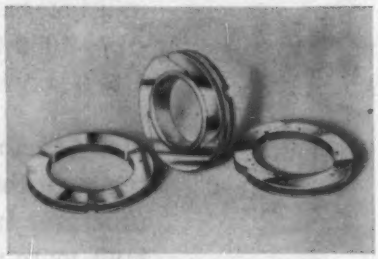

### Very High Finish on New Packing and Scraper Rings

A major improvement in the metal finish of packing and scraper rings used in floating metal packing for compressors handling air and other industrial gases has been announced.

The new rings have a surface finish of less than 10 micro inches on the annular surfaces, whereas previous rings had a finish of 30 to 40 micro inches. These new rings are also flat within light band readings, resulting in more perfect sealing over a broader range of applications. The described improvements are now standard on all production rings. The Garlock Packing Co.

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### Pail Closure Inserted After Pail Is Filled

For the first time fillers of pails will be able to insert pail closures after the pail is filled as part of the filling operation.

The pail openings are formed by the container manufacturer from dies furnished by American Flange. The filler gets the fitting already assembled: nozzle, spout, inner seal, cap, etc., ready to be dropped into place and securely crimped over the opening.

A new brochure describes how the Clinch-On nozzle works and how it can be adapted to your pail filling operations. American Flange & Manufacturing Co., Inc.

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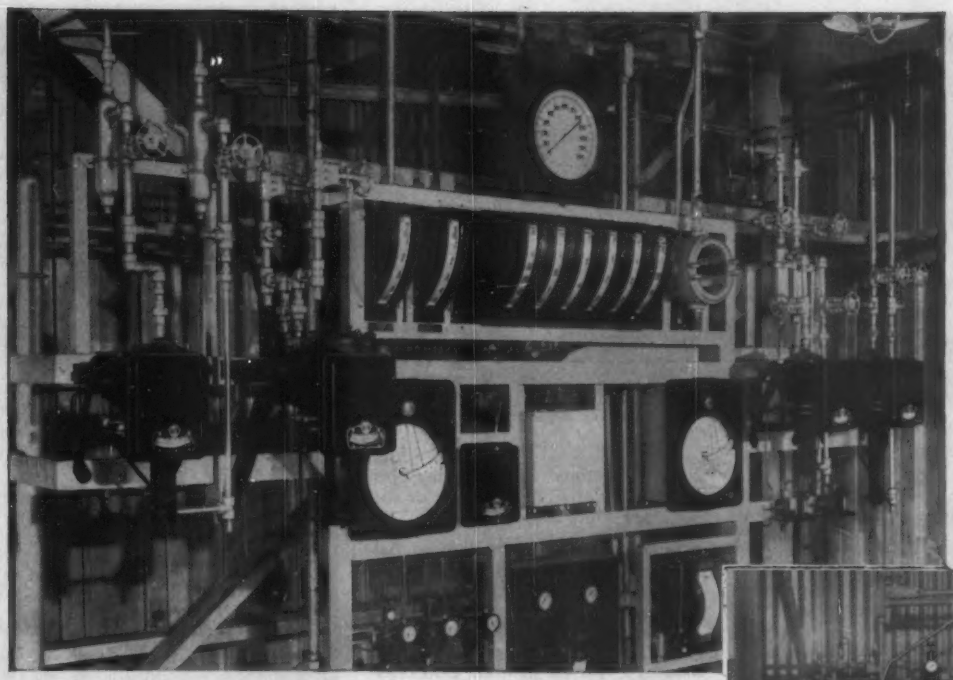
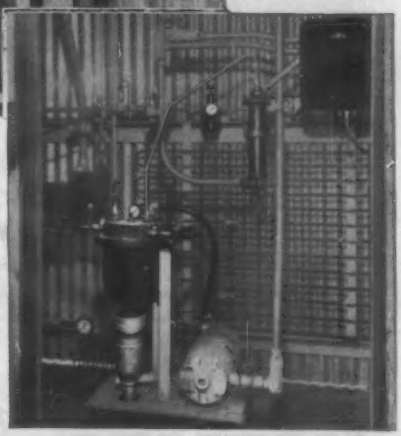
### Pamphlet Tells How To Maintain Wooden Pallets

A technical pamphlet entitled "Care for Wooden Pallets Can Control Maintenance Costs To You" is now available. This publication has been prepared for industry



These Bailey Pneumatic Transmitters on CO boiler at Tidewater measure and transmit: Fuel gas flow, drum level, per cent oxygen, steam pressure, furnace temperature, CO gas flow, steam flow, duct and furnace pressures. Other Bailey transmitters (not shown) measure feed water flow, oil flow, air flow, and steam temperatures.



Bailey Gas Analyzer for oxygen and combustibles in flue gas.

# Bailey Control for CO Boiler at Tidewater...

Bailey Instruments and Controls help Tidewater Oil Company to secure design performance from the new carbon monoxide boiler in its Delaware Refinery. The Bailey Equipment here is of the pneumatic transmission type operating on a standard 3-15 psi signal range. This allows a wide selection of receiving instruments for control room service.

Bailey Controls on the CO Boiler function to maintain:

1. Steam Pressure
2. Steam Temperature
3. Elevated Furnace Temperature for combustion of CO
4. Optimum fuel-air ratio for all mixtures of CO and supplementary fuels
5. Safe water level in boiler drum
6. Proper differential between pressures in boiler drum and at feed water pump outlet
7. Circulation through boiler feed pumps.

For combustion "know-how" with standardized instrument and control components, see your local Bailey Engineer or call our headquarters at Cleveland.

CP2-1

BAILEY BUILDING BLOCK METHOD

**BAILEY METER COMPANY**

CHEMICAL AND PETROLEUM DIVISION

1043 IVANHOE ROAD, CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS



For more data on advertised products, use Readers' Service Cards, last page.

## REDUCE OPERATING COST of VACUUM SYSTEMS with this "AERO" (air-cooled) VAPOR CONDENSER

With free air the cooling medium you use the least water, evaporated in the air stream. You save the cost and pumping of large volumes of condensing water.

Air-vapor subcooling reduces mixture evacuated from the system, saving in the operation of steam ejector or vacuum pump.

This *air-cooled* condenser gives you more capacity than other types at a substantial saving of steam and power. Water supply, scaling treatment and disposal problems are eliminated.

You get pure condensate, an improved product; often make a profit on recovery of residues now wasted. There can be no contamination of your product at any time; it never touches raw water. Condensing, of water, of solvents or of your product, is simplified; you have one, compact, easily maintained unit replacing both cooling tower and barometric or surface type condenser.

*Niagara Aero Vapor Condenser. This compact machine may be installed directly above stripping column or vacuum evaporator.*

Maintenance expense is low. Balanced Wet Bulb Control provide precise, year 'round adjustment of capacity to load.

Constant temperature, uniform products and maximum production 12 months a year are assured. Unit capacities up to 15 million BTU.

*Write for full information. Ask for Bulletin 129R*

**NIAGARA BLOWER COMPANY**

**Dept. PR-4, 405 Lexington Ave., New York 17, N.Y.**

*Niagara District Engineers in Principal Cities of U. S. and Canada*

Quoth Sir Galva-Knight:

## "NEVER GIVE RUST A START!"

Give it even a tiny chink, and rust can quickly ravage steel structures or equipment. Only *hot-dip galvanizing* can seal up every nook and cranny, inside and out, with an armor-tough coating of zinc, actually alloyed with the steel. To stop rust before it starts, specify hot-dip galvanizing by the Nowery J. Smith Company, the South's largest commercial galvanizers.

*Nowery J. Smith* COMPANY

**Commercial Galvanizing**

**Pickling, Oiling, Metallizing, Sandblasting, Prime coating, and/or painting.**

8000 Hempstead Hwy. UNderwood 9-1425
P. O. Box 7398 Houston 8, Texas

one of the SMITH foundries

Serving the Southwest


## New Equipment . . .

which utilizes modern methods of materials handling in their manufacturing, warehousing and transportation operations. It is intended as a guide to pallet users in preventing damage to wooden pallets during use and in assisting in the proper methods of maintenance once damage has occurred.

The pamphlet starts with an explanation as to how to get the most out of wooden pallets in industrial operations. This is followed by a set of nine rules for proper pallet care. It continues with a section on pallet maintenance, which provides criteria on how and when to repair pallets. The pamphlet concludes with a section devoted to preventive measures designed to keep wooden pallet damage at a minimum. National Wooden Pallet Manufacturers Assn.

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### In-Place Cleaning Service For Process Equipment

A service for the in-place cleaning of petroleum refinery and petrochemical process equipment, particularly the product side of such equipment, has been developed.

The service provides chemical cleaners, developed specifically for the removal of product and coolant soils; technical manpower and supervision; and special auxiliary equipment, including mobile cleaning units, gas- or oil-fired steam cleaners, fireless steam cleaners, and powerblast units. The equipment is mounted on flat-bed tractor-trailers.

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n-Dotriacontane
n-Hexacosane
n-Octacosane
Pentaphenylethane
n-Tetratriacontane
1-Phenylcyclohexene
bis-Aminoethyl methylamine
α-Methyl styrene oxide
1,7,7-Trimethylbicycle [2.2.1] heptene-2 (Bornylene)
2,2,3,3-Tetramethylbutane
2,2,3,3-Tetraphenylbutane
Trimethylacetonitrile (tert-Butyl nitrile)
Tricyclodecane (Adamantane, Diamantane)
Prehnitene (1,2,3,4-Tetramethylbenzene)
1,2-Dibromocyclobutane
N-Methyl pyrrole

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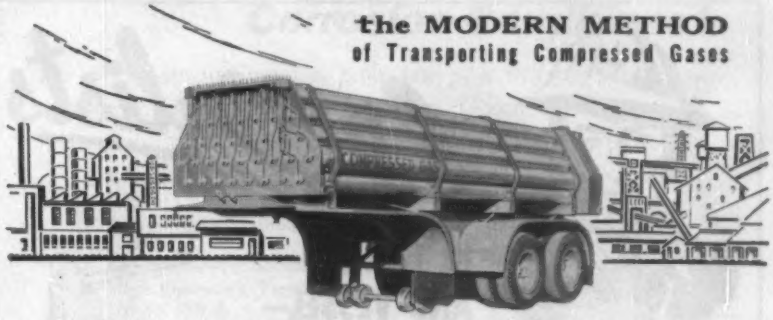

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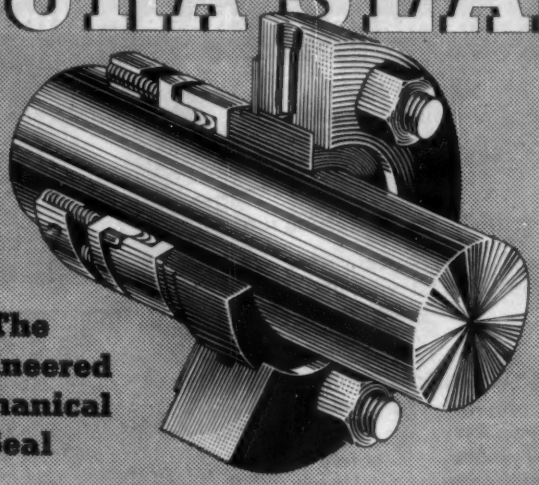

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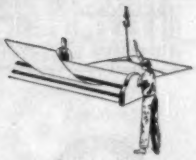

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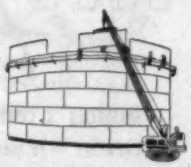

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The company's sales and service engineers provide scientific, technical assistance and practical chemical cleaning and operation supervision experience. Non-technical manpower is provided by the customer. Kelite Corporation.

**Circle E20 green card, last page**

### 88-Page Catalog Covers Complete Line of Controls

A new 88-page publication covers the complete line of control devices manufactured by General Electric's General Purpose Control department. Selection charts covering starters through 200 horsepower provide quick selection of the proper starter, heater and pushbutton station for any type of enclosure. The illustrated catalog has guide form specifications for easy and accurate designation of controls by distributors, contractors or architectural specifiers.

This two-color publication includes complete product descriptions of motor starters, contactors, relays, solenoids, limit switches, pushbuttons and pilot devices. It also contains prices, features, wiring diagrams, dimensions and application information for each device.

Indexed for easy reference, the detailed booklet includes the department's new "100 Line" manual and magnetic motor starters, illuminated oiltight and push to test pushbuttons, and full acceleration part-winding starters. General Electric Co.

**Circle E21 green card, last page**

### Control Catalog Presents Data On Magnetic Relays

A 60-page catalog No. 858 entitled, "Mercoid Automatic Controls for Pressure, Temperature, Liquid Level and Mechanical Movement" has just been released. Catalog also presents data on relays and both magnetic and tilting type mercury switches.

Book is fully illustrated and provides ordering and application information. The Mercoid Corp.

**Circle E22 green card, last page**

### Super-Alloy Tubing For High Temperature Strength

Small-diameter super-alloy tubing for applications requiring strength at high temperatures is described in Bulletin 70 just published.

The materials listed as super alloys in the bulletin are those which will not rupture under a stress load of 25,000

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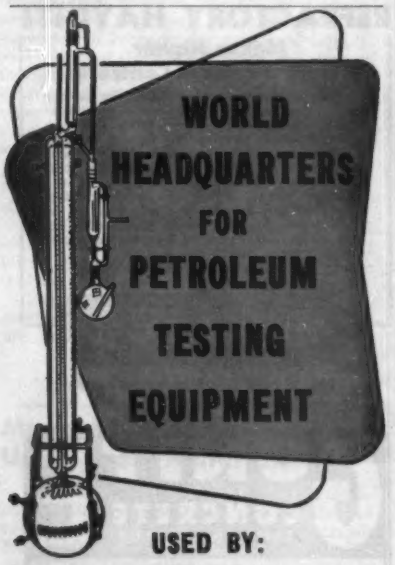


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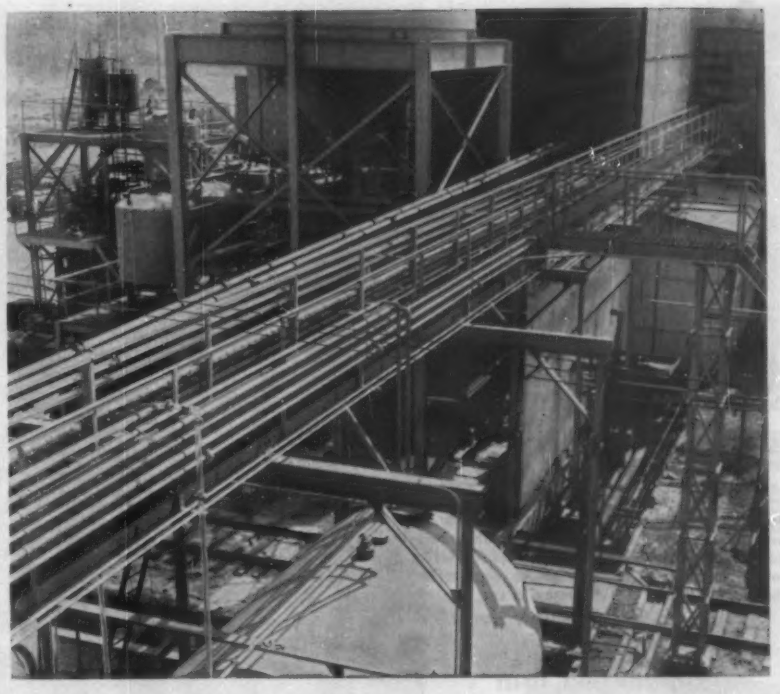

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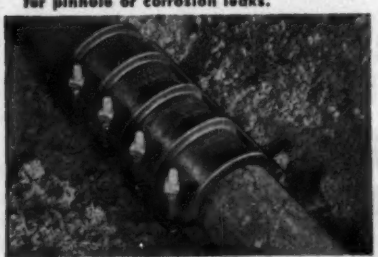

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## New Equipment . . .

pounds per square inch at 1,200 F. during a 1,000-hour test period and which resist oxidation and other types of corrosion.

The bulletin gives the chemical composition, physical and mechanical properties and production limits for the 16 super alloys in the line. Graphs show the ultimate strength and yield strength and percent elongation in 2 inches at elevated temperatures for eight of the alloys. Also shown in graph form are preliminary stress-rupture tests on 15 of the super alloys. These were the first such tests made on super alloys in small diameter tubing form.

Precipitation hardening treatments for three of the hardenable alloys are described in one of the tables. Other tables list stress to rupture and creep strength data at high temperatures. Superior Tube Co.

Circle E23 green card, last page

### Laboratory Chromatograph Described On Data Sheets

Three new sheets on Gas Chromatographs and accessories describe: the low cost, low temperature Beckman GC-1, for routine laboratory separation and analysis of gases and liquids boiling up to 80 C; the versatile, high temperature Beckman GC-2, for thousands of routine laboratory analysis of gases of liquids boiling up to 350 C; and the complete line of sampling accessories and column information that extend the range of applications of both instruments. Beckman/Scientific Instruments, Division of Beckman Instruments, Inc.

Circle E24 green card, last page

### Brochure Tells Features Of the Fast Coupling

The metal products division has announced the publication of a new brochure on the use of Fast's Model B couplings. According to the company, this is the first low-priced, all-steel, gear-type, self-aligning coupling ever produced for shaft sizes up to three and one-eighth inches.

The brochure outlines the principal features of the line of couplings and points out that the double engagement design compensates for any type of misalignment of the shafts. Ratings and dimensions of the couplings are also included. Koppers Co., Inc.

Circle E25 green card, last page

### Low Voltage Equipment and Parts in 144 Page Catalog

Low-voltage distribution equipment and components are the subject of a new 144-page, 1958 general catalog, issued jointly by the company's Circuit Protective Devices and Distribution Assemblies departments.

The new catalog provides condensed information on all products of the two departments—safety switches, disconnet switches, open-knife switches, circuit breakers, service entrance equipment, lighting and distribution panelboards, wireway, switchboards, motor control centers, sectional-type distribution center unit substations, and busway. General Electric Co.

Circle E26 green card, last page

### Stabilize Oil Color With Multi-Purpose Inhibitor

The development and commercial availability of a new, multi-purpose dispersant inhibitor for petroleum products has been announced.

Bearing the trade name, POLYFLO 100, the new dispersant has also proved exceptionally potent in minimizing deposits and stabilizing color in diesel oils, distillate burner oils, and residual fuels. Depending upon the application, from 5 to 15 pounds of the additive is required to treat 1,000 barrels of product.

Applied to refinery streams, the new additive prevents deposition and fouling in heat exchangers and reboilers. Crude oil and residual fuel oil tanks and transfer


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## New Equipment...

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**Circle E27 green card, last page**

### Tubing Tolerances Shown On Technical Data Card

Engineers, estimators, buyers and others concerned with seamless mechanical tubing tolerances will be interested in the technical data card now available. This card, TDC-115D, furnishes popular data taken from the new edition of the Steel Tubular Products Section of the AISI Steel Products Manual. The data card covers, in detail, the important dimensional tolerances, both cold-drawn and hot-finished, of round, seamless carbon and alloy steel mechanical tubing in various conditions of heat treatment. The Tubular Products Division of The Babcock & Wilcox Co.

**Circle E28 green card, last page**

### Flow Controller Described In Technical Bulletin

A new bulletin describes two flow controllers that provide constant flow, independent of variations in upstream and downstream pressure, for gases and liquids.

A constant differential pressure (approximately 3 psi) is maintained across an external needle valve by the action of the valve in the controller. This differential, determined by the force of the loading spring, also exists across the flexible diaphragm of the controller. Adjustment of the needle valve provides accurate flow setting.

The flow controller finds its principal use in the determination of the liquid level in open vessels and pressure tanks through the use of differential pressure.

The bulletin describes the complete operation of the differential system to measure liquid level. Sunvic Controls, Ltd.

**Circle E29 green card, last page**

### Manual Aids In Design Using Brass Materials

Publication of a revised, 44-page manual to assist engineers in the selection of condenser tube and tube sheet materials has been announced. The booklet discusses the application and installation of copper and copper alloy condenser and heat exchanger tubes, also plates for tube sheets, heads and baffles. Included is a review of corrosion factors in condenser tube service.

The data provided are especially for engineers responsible for the selection of material in the oil refinery and process industries. The information presented is based on the records of actual installations as well as the company's continuing laboratory studies. The American Brass Co.

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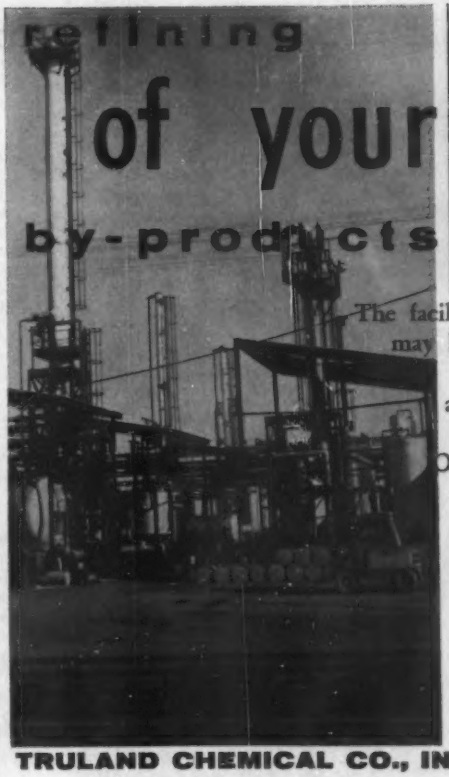

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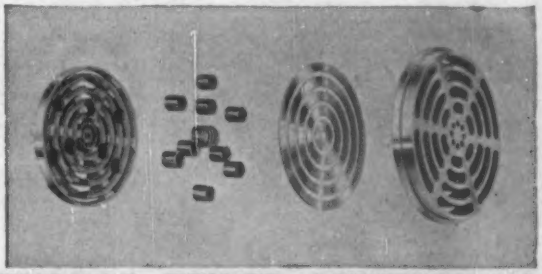

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## PETROLEUM REFINER Readers' Service Card

April, 1958, Issue*

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(see Page 164)

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| 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 |
| 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 |
| 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 |
| 118 | 119 | 120 | 121 | 122 | 123 | 124 | 127 | 130 | 134 | 211 | 213 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 |
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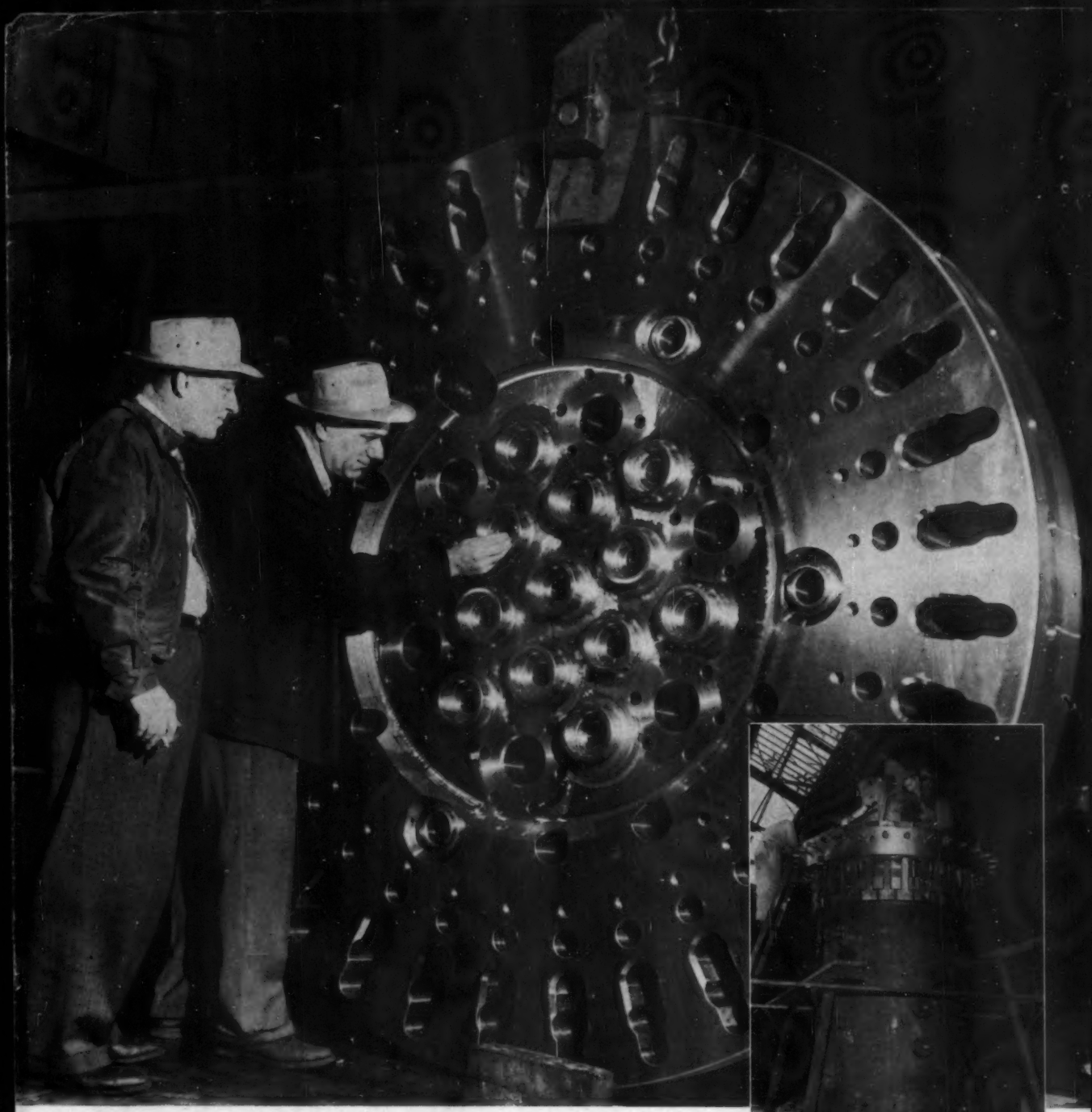
**Houston 1, Texas**



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